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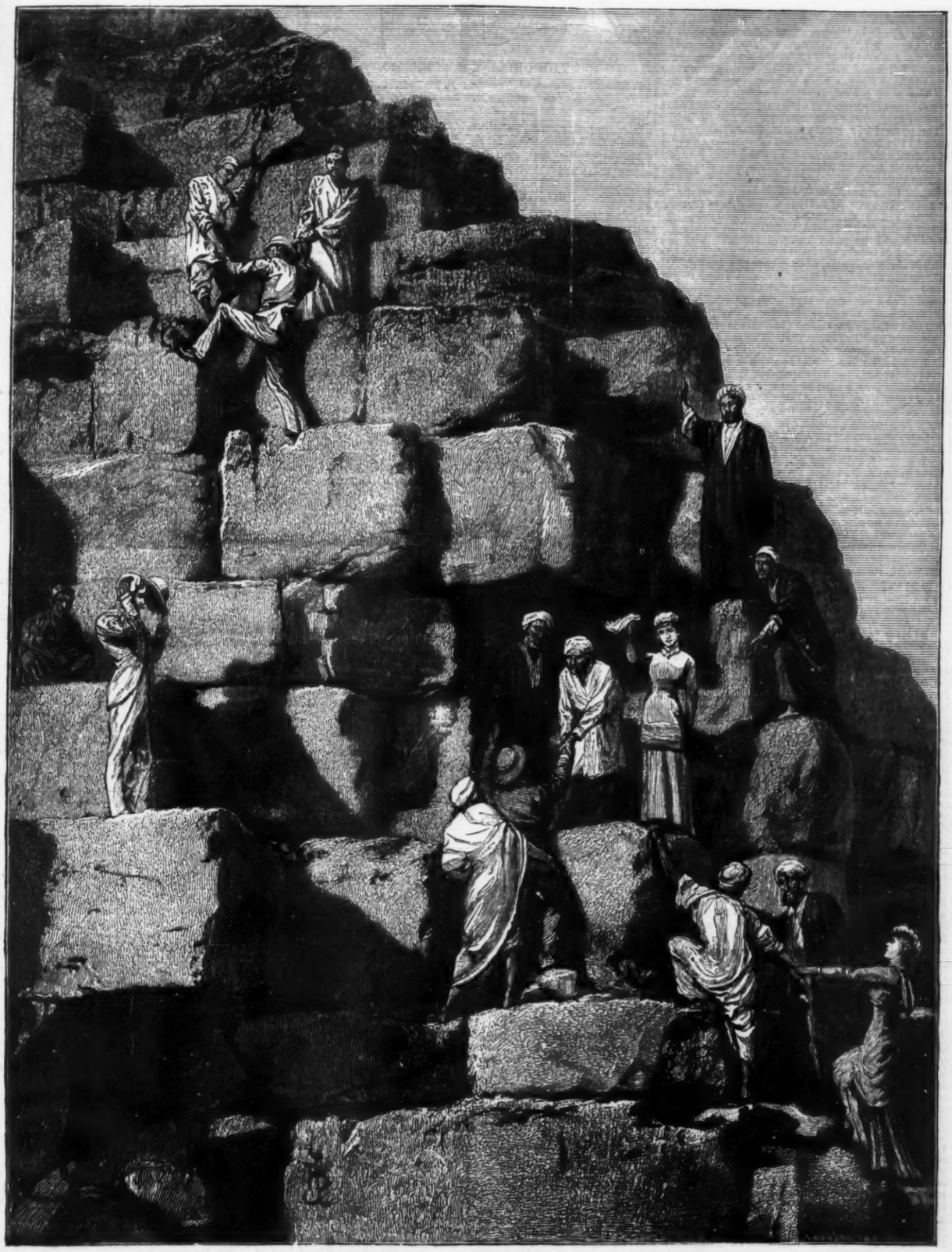


THE GREAT PYRAMIDS OF EGYPT.—CLIMBING THE SUMMIT.

THE EGYPTIAN PYRAMIDS.

IN connection with the description of the Egyptian obelisk, lately brought from the Nile and erected in Central Park, New York, we have thought that our readers might be interested in some of the other remarkable architectural remains with which Egypt so abounds. The London *Graphic* has lately published a series of admirable engravings of some of the wonderful objects seen by its correspondent during a recent Nile tour. From this series we transfer on the front page the view of one of the great pyramids of Ghizeh, which stands in the ancient cemetery of Memphis.

The facts that the pyramids are found in the midst of a necropolis, that they contain sarcophagi and mummies, and that the inscriptions on the tombs of many priests mention as a special honor that the deceased officiated at the funeral services held at the pyramids, seem to prove that they are tombs and nothing else. As the Egyptian tombs have always borne one and the same character, and only the manner in which they were adorned varied with the tastes of the period, their age may be determined with great certainty. For the first eleven dynasties, or previous to about 3000 B.C., the tombs were in the form of a *mastaba*, or merely rectangular walls looking like unfinished pyramids, and their interior was richly decorated with sculptures and paintings, referring either to the life of the deceased or to the gods of the current religious system. During the middle empire, and until about 1600 B.C., the *mastaba* was superseded by small pyramids, and by the *speos* or halls cut into the rocks, and the divinities were seldom represented upon them. In the next period, until about 340 B.C., the excavated tombs prevailed, and the statuary and images of the deceased were superseded again by those of a mythological nature. The pyramids are only enlarged *mastaba*, and belong as such to the first period. Each one was commenced over a sepulchral chamber excavated in the rock, and during the life of the king for whom it was intended the work of building up the structure over this chamber went on, a very narrow and low passageway being kept open as the courses of the stone were added by which access from the outside was secured to the central chamber. At the death of the monarch the work ceased, and the last layers were then finished off and the passageway closed up. The piles were constructed of blocks of red or Syenitic granite from the quarries of Asswan, and also of others of a hard calcareous stone from the quarries of Mokattam and Turah. They were of extraordinary dimensions, and their transportation to the pyramids and adjustment in their places indicate a surprising degree of mechanical skill. Their thickness varied from more than four to less than two feet, and when arranged one upon another, forming steps up the outer slopes, the thickness of the stones determined the height of these steps. Those near the top are of the thicker stones, but the blocks are of moderate length compared with those near the base. The foundations for the structures were excavated in the solid rock, sometimes to the depth of 10 ft., and upon this the great stones were arranged and built up layer upon layer, and one shell succeeding another, the spaces within being filled in with smaller stones closely packed. To quarry and move the immense blocks to the pyramids and then raise them to their places required no little engineering skill, notwithstanding an unlimited amount of human labor was at command. Near the summits the number of men that could aid in raising the huge stones must have been comparatively small for want of room, and it seems that some mechanical power must have been employed besides any which we know they possessed. The probability of this is confirmed by the fact that cavities in the stones have been found which appear as though they might have been worn by the foot of derricks turning in them. The three pyramids of the Memphis group stand upon a plateau about 137 feet above the level of the highest rise of the Nile, not far apart, and nearly on a northeast and southwest line. Like the other pyramids of Egypt, their four sides are directly toward the cardinal points. The largest of them, known as the Great Pyramid, or the pyramid of Cheops (Khufu, or Shufu), covers at present an area of between twelve and thirteen acres. Its dimensions have been reduced by the removal of the outer portions to furnish stone for the city of Cairo. Thus despoiled, the walls have lost their smooth finished surface, in which state they were left by their builders, who, beginning at the top, filled in with small stones the angles formed by the recession of each upper layer, and beveled off the upper edges of the great blocks, till, reaching the base, they left each side of an even surface sloping at an angle of 51° 50'. By stripping off the outer casing the courses of stone appear in the form of steps, which, though ragged and unequal, can be ascended even by ladies. The Great Pyramid has 203 of these steps, the lower one being 4 feet 10 inches high. The horizontal surfaces were nicely finished, and the stones were joined together with a cement of lime, without sand. The masonry of the Great Pyramid consisted originally of 89,028,000 cubic feet, and still amounts to 82,111,000 feet. The present vertical height is 450 feet against 479 feet originally, and the present length of the sides is 746 feet against 764 feet originally. The total weight of the stone is estimated at 6,316,000 tons.

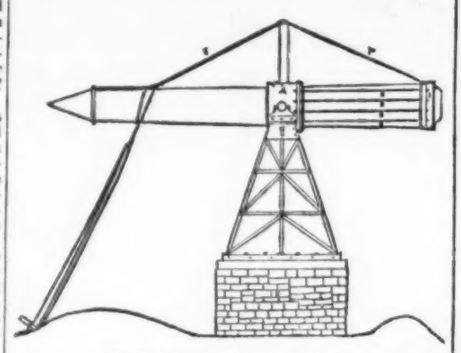
The second pyramid, King Shafra's, stands on a base 33 feet above that of the Great Pyramid, and in an excavation made for it in the rock. It measured originally 707 feet 9 inches on the sides, and was 454 feet 3 inches high; but these dimensions are now reduced respectively to 690 feet 9 inches and 447¼ feet. The angle of its slope is 53° 20'. The upper portion of its casing is still preserved, and persons can ascend this, though not without danger, especially if liable to become dizzy by losing sight of the lower portion of the structure.

The third pyramid is only 354½ feet square and 203 feet high, but was originally 219 feet high. It was explored in 1837 by Col. Vyse, who discovered several apartments, in one of which were a highly finished sarcophagus, a mummy case bearing the name of King Menkara, and the body of a workman. The last two are now in the British Museum, but the sarcophagus was lost on the passage. This pyramid, though the smallest, is the best constructed of the three, and, indeed, the style of the work is more costly than that of any of the other pyramids of Egypt. In the same vicinity are six smaller pyramids, supposed to have been the tombs of some of the relatives of the kings who constructed the larger ones, and an immense number of tombs, some built up above the surface, some excavated in the rock, and some subterranean channels. Near the Great Pyramid is also the famous Sphinx.

THE author of the "Physical Treatise on Electricity and Magnetism," has devised a new apparatus for producing electric light, consisting of an arrangement of small balls of platinum or iridium at the ends of platinum wires, in pairs, in the middle of a suitable globe.

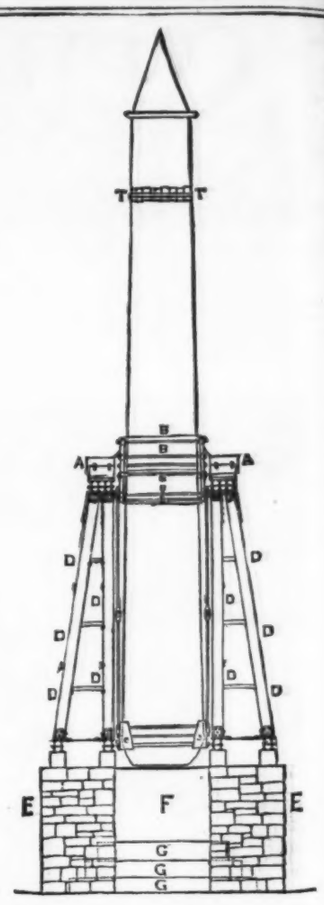
THE EGYPTIAN OBELISK IN CENTRAL PARK.

LAST week we gave in our SUPPLEMENT a number of views illustrating the great Egyptian obelisk, lately erected in Central Park, New York. We now add two diagrams illustrating the method by which the enormous stone was suspended and then placed in its upright position. These diagrams in connection with the descriptions given last week will fully explain the subject.



THE OBELISK SUSPENDED.

T. Steel wire rope truss. A. Trunnion. B. Tie Rods. C. Friction straps. D. Steel tower. E. Masonry piers.



THE OBELISK ERECTED.

T. Truss band. A. Trunnions. B. Trunnion bolts. C. Friction clamps. D. Steel towers. E. Masonry foundations. F. Pedestal. G. Steps.

ISLANDS ABOUT NEW YORK.

THE tribes of islanders that burn their council fires hereabout—the Manhattan Islanders, and the Long Islanders, and the Staten Islanders, and the many other islanders—know less, usually, about their own little islands than they know about any other inhabited part of the world. One of our public school boys could tell you the capital of Arkansas, and bound the desert of Sahara; but if he should suddenly be sent on an errand to Ward's Island, it is ten chances to one he would have to look on a map to find it, and after he found it he would not know how to get there. Here are 2,000,000 of us, all islanders, and most of us know as little about the dozen islands that go to make up this metropolis as if they were in the middle of the Bay of Biscay. Manhattan Island we all know something about; how the North River is on one side of it, and the East River on the other; and the Harlem and Spuyten Duyvel Creek at the top and the Bay at the bottom; and Staten Island is not entirely new to us, though it would be easy to find half a million people in New York who have never looked upon that beautiful side of Staten Island that is washed by the Kill Von Kull, nor taken the walk along the north shore that leads past the Sailors' Snug Harbor—a region that in the summer time is little short of fairy land. Long Island is becoming pretty well known, though the more remote parts of it are still perfect storehouses of antiquity, running over with quaintness, and untouched by the spirit of the times. Manhattan Island to-day is very little like the Manhattan Island of a century ago, for it has grown almost as fast as the city. There are now big warehouses standing on exactly the spot where one hundred years ago ships lay at anchor. Hundreds upon hundreds of acres have been added to the island, that have not only increased its area, but have very materially altered its shape. If any one man owned all the land that has been added to this island in the last fifty years, he might lend money to the Vanderbilts and the Astors. A map of this island, with the "made" land printed in black, as they used to map off the slave States, would have an alarmingly black face. We have grown so fast that we have had, in great part, to make the land we live on. Not only have we run our boundaries out into the rivers, but we have taken swamps and filled them up, and built rows of houses on them; and we are still at it, with plenty more swamps in the upper part of the city still to be filled.

It is going to be something of a sea voyage, this tour of the islands. It will take us into the Bay, up the East River, and through the still turbulent currents of Hell Gate. With our boat in the hands of a good pilot, it is as safe a trip as crossing Broadway; but if our pilot is not an old hand, and a steady one, we had better have the life preservers ready. Where are we going? By your leave we will visit six islands—Blackwell's, Ward's, Randall's, Hart's, Bedloe's, and Governor's, all, you will notice, named after individuals, except the last. These islands are all public property, the first four belonging to the city, and the last two to the Government. And Blackwell's Island being the first on our list, we will turn our boat's head thither. It is founded upon a rock, as we can see with half a glance; and it is easy to imagine the slow process that turned a projecting rock into the long, narrow strip of land that now lies between this city and the Long Island shore. Immediately below it the sharp point of a rock sticking out of the water tells of the rocky character of the bed of the river. A little matter of a few thousand years ago the rock that showed its head in the East River caught the wash of the tides that swept from the Sound into the Bay. Every tide added a little, till the bare rock became an island.

Blackwell's Island is, unfortunately, the best known of all our islands. The statues of spartan justice known as the police magistrates, invariably speak of it as "the Island." The citizen of the world who shuffles along when the policeman tells him to move on, and always, somehow, shuffles himself into a police station, can tell you all about "the Island." Sometimes he will not enter so far into details as to mention the Island at all, but will merely tell you that he was "sent up" and that he "came down." There is an underground railroad from Blackwell's Island to the city, as everybody knows. Thieves go to the island by boat and come back by the underground. Precisely where the stations are is hard to learn, but it is a busy railroad. I have seen many passengers who have traveled over it, but one sample is enough. It is a woman who keeps a disorderly dram shop in a basement in Chatham street. I heard that woman plead guilty, in the General Sessions, of keeping a disorderly house, and heard the judge sentence her to six months on the Island. This was on a Tuesday. The following Saturday the woman was behind her bar again, and has been there from that day to this, nearly two years. She came down by the underground railroad. I have heard Justice Duffy say to a seedy prisoner in the Tombs Police Court, "this is the second time I have sent you to the Island this week," and he had sent him for six months each time. That fellow had come down by the underground road, and he knew where the stations were. It is not to be supposed from this that the warden is such a careless officer that he lets his prisoners walk away when they will. On the contrary, escapes are very uncommon. It is well known among the prisoners that, for regaining lost liberty, a second cousin in the Board of Aldermen is better than two saws and a file. But here is the island, the lower end of it just opposite Forty-sixth street. It has a population of 7,000, and a queer place it is, and many an interesting story it could tell. It is a settlement of criminals and incapables. The buildings on it, that occupy a good deal of space and still cover only a small part of the one hundred and twenty acres of land composing the island, are the penitentiary, the almshouse, the lunatic asylum for females, the workhouse, the blind asylum, the charity hospital, the hospital for incurables, and the convalescent hospital. The first building, the big gray stone one, is the charity hospital. Would that every one of the patient sufferers in that grim building might be as successfully and skillfully treated as was the writer of this article when he was once one of its inmates. It was on a frosty night one January, snow falling, the river full of ice. Some prisoners had escaped, and it was necessary to make a midnight visit to the island. The business was done, and the ice-coated boat was about to put off again, when the doctor came out. "Hold on," said he, "you are shivering. The cold has upset your stomach and your nerves are shaky. A glass of brandy will warm you up, and a cigar will steady your nerves. Come into the hospital." The prescription worked like a charm.

The penitentiary, the second building and the largest on the island, is known by almost everybody from its peculiar shape and its long rows of narrow, iron-barred windows, which show it at once to be a prison. It is built of stone quarried out of the island, and put together by convicts, and is a monument to the fact that the slowest sort of a machine, if kept steadily at work, will in time accomplish a great deal of labor. To see the Blackwell's Island convicts at work nobody would suppose that they could ever build a house. They move around with the easy grace and celerity of so many snails. To go to the pump and fetch a pail of water would be half a day's work for some of them. The street sweepers, who are popularly but erroneously supposed to sweep the streets of New York, are rapid in their movements compared with these enforced laborers. If anybody wants to know what slave labor was, let him go over to Blackwell's Island and see these convicts at work. Yet by patient toil they have quarried out the stone, built a little city, and built a substantial sea wall all around the Island. The penitentiary usually has about 1,200 inmates. The prisoners are taken out to work in "gangs" of 40 or 50 men, under charge of two officers. The officers have policemen's clubs and revolvers, and sometimes have to use them. Although the more desperate criminals do not often find their way to the island, prisoners have frequently risked their lives by attempting to swim to the New York shore. This is a perilous feat, and is not often successfully accomplished; not that the distance is so great, but the current is so swift. Many a poor fellow in a striped shirt has struck out into the icy water for liberty or death, and reached death first. Not far from the prison, and down facing the Long Island shore, is a large frame building, whose lower story is a carpenter's shop. Enter it when you will in working hours, and you will see a long row of men all at work mak-

ing boxes. Big, rough, pine boxes, with big, rough, pine covers. These rough boxes are the city's parting gift to the city's pauper dead. The worth of one of them, little as its worth is, might have kept the poor wretch from starving, but then he could not get it. Now he is dead, he may have it, and no questions asked. The almshouse is full enough, for a city so prosperous that trade dollars are rolling down the hills and bouncing off the piers into the river; the lunatic asylum for women is noisy; the workhouse, whose very name is a terror to the tramps, is never lonesome; the hospital for incurables has a weak and hopeless population; the convalescent hospital does not fill up so fast. Beyond the buildings is the little farm, where the cheap diet of the Island is supplied. At the very uppermost end is a lighthouse. It was on this upper end that poor old Thomas Maxey built his fort. For years he worked at it, and fortified it with a wooden gun to strike terror into the hearts of all the oyster sloops coming down through Hell Gate. The fort stood there for a long time, and Maxey, a harmless lunatic, made it larger every day. He had no sooner finished it than he died, and he was no sooner dead than the commissioners tore the fort down and sent the wooden cannon floating down the river.

Next above Blackwell's Island is Ward's Island, and a dangerous piece of water lies between them. It is the inner edge of Hell Gate, with a current fit to wash the keel off a ship. Ward's Island forms the northern boundary of Hell Gate, and is separated from Randall's Island on the north only by a small but swift channel known as Little Hell Gate. The island is nearly round, and contains about 200 acres. It has some very pretty trees, and in the summer time it is dressed in a cloak of green that does the eyes good to look at. Like Blackwell's Island, Ward's Island belongs to the city; but two sets of commissioners have it under their charge—the Commissioners of Public Charities and Correction and the Commissioners of Emigration. The Charity Commissioners have an insane asylum for males, an inebriate asylum, a homeopathic hospital, and a soldier's retreat. The Emigration Commissioners have the State Emigrant Hospital, a lunatic asylum, houses of refuge, and a nursery for children. The public buildings lately erected upon this island are of the largest and handsomest kind, and will compare favorably with the charitable institutions of any city in the world. The lunatic asylum particularly is one of the ornaments of the city. It looms up like a mountain. It is built of brick, with stone trimmings, and has a great many wings, all highly ornamented. It contains about 700 patients at present. The population of this island is about 3,000, of whom nearly 2,000 are immigrants. Thousands of immigrants reach Castle Garden without money, without friends, with no knowledge of the language, and often with no knowledge of any trade. If these people were not cared for they would soon be begging in the streets. But they are taken to Ward's Island, housed and fed. While there they do such work as they are able to do, and, as soon as openings are found for them, they are sent to the West. If they are sick they are put in the hospital. It is a branch of the municipal government unknown to the European cities, but very necessary here. The grass and the trees are a pale sickly yellow, compared with the bright greenness of most of those immigrants when they first reach New York. The immigrant who let a stranger carry his pocketbook around the corner, just to show that he had confidence in him, was not at all exceptional. The Soldiers' Retreat is an asylum for invalid soldiers of the rebellion who served in regiments raised in New York City. It is well peopled, and the veterans have a snug, shady home, well removed from the bustle of the city.

Randall's Island, the third of the row of three islands in the East River, is the smallest of the three, containing only about 100 acres. It can hardly be said to be in the East River, for it is bounded on the north by the narrow channel, known as the Harlem Kills, which separates it from the Westchester shore, on the south by Little Hell Gate, and on the west by the Harlem River. On it are the House of Refuge, the Idiot Asylum, and the Children's Hospital. The House of Refuge is its principal building, a handsome brick structure, with three domes. It contains usually about 800 children, both boys and girls, kept in separate buildings. It is in part a penal institution and in part a reformatory—a mixture that breeds better results than might be expected; but still it is not a place that any considerate parent would care to have his boy graduate from. If a boy breaks into a store and steals what goods he can lay hands on, he is sent here for punishment. Another boy is guilty of the crime of being deserted by his parents, and he is sent here to be taken care of and "reformed." The boy who knows how to steal soon teaches the one who doesn't. The discipline of the institution is very strict, and the boys have a cowed way about them that is anything but pleasant. Its managers have difficult work, for they have to deal at once with many of the worst young ruffians in the city, and with unfortunate little fellows whose only sin is poverty. The House of Refuge is a father to many such, with a father's protection and a father's stern rule; a little more of the mother and a mother's tender kindness would not come amiss. It is one of the healthiest spots around New York, reports to the contrary notwithstanding. There is hardly ever a child in the hospital. The girls do the housework and sewing, and the boys work a given number of hours, and study the remainder of the day. The school is an excellent one, and the instructors may, for that reason, perhaps, be glad to have one of the greatest defects brought to their notice. The slang and drawl of the street Arab are in common use in the schoolroom. A boy will go to the front in the classroom, work out a mathematical problem that would puzzle many of his elders, and then explain it in the language spoken on the wharves and about the market. "De first quantity is multiplied by de second, and dis is de remainder." This is only a mild example of this dialect of the streets, with which everybody is more or less familiar. The population of Randall's Island is about 2,500, most of the inhabitants being children, who are locked up in cells regularly every night, and set to work again next morning. Among the industries taught the boys is the art of printing, and they do work that does them great credit.

It is a long trip through Hell Gate and up the neck of the Sound to the next island, which is Riker's. But as this contains nothing of any interest, and is not contained in our programme, we have nothing to do but sail past it, and keep on sailing till we reach Hart's Island—"the least interesting of all the islands belonging to the city," the guide books tell us. But in this the guide books are greatly mistaken, for Hart's Island contains enough of interest for a day's visit. Its most important part is the city burying ground—the Greenwood of the Five Points. This is where the rough pine boxes go that come from Blackwell's Island. The horrors of the Potter's Field are not pleasant things to read about, and need not be dwelt upon. There is an industrial school on the island with 300 pupils, and when the little boys and girls have behaved themselves well through the week, and the weather is fine, the teachers let them have a half-holiday on Saturday afternoons, and go out and play among the graves. There is also a branch lunatic asylum and an almshouse on the island.

It is time to turn about and steam down the river again. We have still to visit Governor's Island and Bedloe's. The little island called Ellis's Island, a mile and a half southwest of the Battery, is used only for a government magazine, and has not enough of interest to make it worth our while to visit it. Governor's Island comes first. It is about 1,000 yards, or, say, two-thirds of a mile from the Battery, though the distance looks much less. It is separated from the Brooklyn shore by Buttermilk Channel. Its chief curiosities are Fort Columbus, Castle William, the South Battery, and one of the latest victims of the alleged Democratic Party. It contains 65 acres, and is the headquarters of the Military Department of the Atlantic. The northern part of the island is fenced off for the use of the Ordnance Department, and this part of the ground is covered with symmetrical heaps of cannon balls. Bedloe's Island is a mile and a half west of Governor's Island, and two miles southwest of the Battery. It is very small, being less than a third of a mile square. The fort upon it, a small one, but solid, is called Fort Wood. It is upon this island that Bartholdi's statue of Liberty is to be erected. One of the hands of this statue has reached Madison Square, and the remainder of it will be along presently.—*N. Y. Times.*

[From NEW YORK TRIBUNE.]

ILLUSIONS OF THE STAGE.

MANY of the peculiar effects produced upon the stage, imitating moonlight, sunlight, thunder, wind, rain, and other natural phenomena, are a puzzle to those outside of the business. How such realistic representations of these things as are often witnessed upon the stage can be made is a question that often enters the mind of the spectator, and is seldom answered in a satisfactory manner. It is always the ambition of scene painters and stage carpenters to devise improved methods of imitating these things, and hence the stage may be said to try to hold the mirror up to nature in a material as well as a moral sense. Years of experience have tended to bring these imitations to a high state of excellence; but the limits do not yet seem to be reached, and new contrivances are continually appearing. The electric light is not yet used, but as its pale bluish tint would be serviceable in particular effects, stage machinists are now deliberating how it can best be employed. All of the operations mentioned, together with some which will be described, are classed under the general term, "stage effects." Authors, in writing plays, are always on the lookout for an opportunity to produce a telling effect. The amount of work bestowed upon their production in a theater is simply astonishing to those unacquainted with that mysterious realm known as "behind the scenes."

Thunder is a common stage effect, and is used with great advantage in many plays. In former days it was produced by shaking a large piece of sheet iron immediately above the prompter's desk. This contrivance produced a good imitation of sharp, rattling thunder, but failed to give the dull roar which is always heard in storms. A contrivance for this purpose was soon invented. A heavy box frame is made, and over it is tightly drawn a calf skin. Upon this the prompter operates with a stick, one end of which is padded and covered with chamois skin. A flash of lightning, produced with magnesium, and a sharp crack of the sheet iron, followed by a long decreasing roll upon the "thunder drum," produce an effect which is startingly realistic. Traveling companies are compelled to be satisfied with the sheet iron alone; and the tragedian who enters a theater provided with a complete thunder apparatus always is happy to think that his battle with the elements in "King Lear" will be worth fighting.

The rain machine in large theaters is a fixture placed high up in the "flies." A cylinder is made of "half inch" wood. It is usually five feet in circumference, and four feet in length. Upon the inside are placed rows of small wooden teeth. A lot of dried peas is placed in the cylinder, a rope belt is run around one end of it and down to the prompter's desk, and it is ready for a drenching shower. By turning the cylinder, the peas roll down between the teeth, and the noise produced by them makes a good imitation of rain falling upon a roof. A sudden pull of the rope, accompanied by a gust on the "wind machine," gives the sound of the sweep of a blast of wind during a storm. Traveling companies often meet with theaters where there is no wind machine. A sufficiently good one, however, is easily produced. A common child's hoop is obtained, and a sheet of heavy brown paper is pasted upon it after the manner of a circus rider's balloon. A handful of birdshot is placed upon the paper. The "machine" is canted from one side to the other, and the shot rolls around the paper, producing a fairly good rain effect.

Wind is an item that is very useful in heightening the effect of stage storms. It is often dispensed with in theaters where strict attention is not paid to details, but not without a loss of "realism." It has, moreover, a great influence over the feelings of spectators. The blind *Louise* in the "Two Orphans" is much more pitied when the audience can hear the pitiless blast that makes her shiver. Hence in every large theater the wind machine plays an important part. It is not a stationary apparatus, but can be moved to any quarter of the compass from which it is desired that wind should blow. In the last act of "Ours," every time the door of the hut opens snow flies in and a shriek of wind is heard. The wind machine in that instance is placed just outside the door, and the property man works it, while his assistant amuses himself by trying to throw his paper snow down *Lord Shendryn's* back. The wind machine is constructed in this manner: A heavy frame is made, in which is set a cylinder provided with paddles and resembling very much the stern wheels seen on Ohio River towboats. Across the top of this cylinder is stretched as tightly as possible a piece of heavy gros-grain silk. This silk remains stationary while the wheel is turned by a crank. The rapid passage of the paddles across the surface of the silk produces the noise of wind. Often traveling companies are in theaters where there is no wind machine. Then the property man groans audibly and proceeds to do what, in theatrical parlance, is called "faking" the wind. He selects a heavy piece of gas hose, called by stage gas-men "flexible," and, finding a quiet corner where there is sufficient space to swing a cat without danger—to the cat—he whirls it around his head with the greatest possible rapidity. This method produces very satisfactory results—to every one but the property man. He is a long-suffering person; but the extraction of wind from "flexible" causes him to find life tedious.

Every one has heard the startling crash that is produced when the hero kicks the villain through a four-inch oaken door. One would think that not only the door but the villain must be completely shattered. This noise is produced by the crash machine, one of the oldest implements of imitation still used on the stage. It is similar to the wind machine in construction. A wheel with paddles set at an angle of about forty-five degrees to the radii is the main part of the machine. Upon the top of the wheel one end of a stout piece of wood is pressed down by fastening the other end to a portion of the frame-work. When the wheel is turned, the slats passing under the stationary piece produce a rattling crash. The principle of the machine is illustrated by the small boy who runs a stick along a paling fence and is gratified by introducing into the world an additional morsel of hubbub.

There is nothing that can be so well counterfeited on the stage as moonlight scenery. And yet there is nothing which requires more work. The artist begins the task by painting a moonlight scene. In daylight such a scene is a ghastly sight. It is done in cold grays and greens, in which Prussian blue and burnt umber play an important part; and the lights are put in with white slightly tinged with emerald green. The strong moonlight of the foreground is produced by a calcium light thrown through a green glass. The fainter light upon the scenery at the back of the stage is obtained from "green mediums," a row of Argand burners with green chimneys. These are placed upon the stage just in front of the main scene, and are "masked in" from the view of the audience by a "ground piece." A row of them is often suspended from the "flies," in order to light the top of the scene. This upper row is masked in by "sky borders." Thus a soft green light is thrown over the entire distance, while its source does not meet the view of the spectator. A usual feature of stage moonlight scenes is water, because it affords an opportunity for the introduction of the "ripple"—a charmingly natural stage effect. The main scene in a moonlight view is always painted on a "drop"—that is, a scene made like the curtain let down between the acts. The position of the moon being determined, immediately under it, beginning at the horizon, a number of small irregular holes is cut in the drop. These are then covered on the back with muslin and painted over on the front to match the rest of the water. Behind these holes is placed an endless towel, about eight feet in height, running around two cylinders, one at the top and one at the bottom. The lower cylinder has a crank by which the towel is turned. In this towel is cut a number of holes similar to those cut in the drop. A strong gas burner is placed between the two sides of the towel. When the machine is turned the flashing of the light from the passing holes in the towel through the stationary ones in the drop produce a fine ripple. It is always better to turn the towel so that the holes pass upward, as that helps to make the mimic wavelets seem to dance up toward the sky. Instead of a towel a large tin cylinder has been used, but it is cumbersome and noisy. It is necessary to turn this towel with great steadiness, otherwise the ripples will go by fits and starts, and entirely lose their natural appearance. Stars are easily put into the sky. Each twinkling orb consists of a spangle hung upon a pin bent into a double hook. The slightest motion of the drop causes these stars to shake and the flashing of the light upon them produces the twinkle.

One of the most beautiful effects produced upon the stage is the change from day to night or from night to day. Of these the former is the more striking, and a description of it will serve to explain the principle of both. In order to produce the proper effect the back drop is made nearly double the height of the usual scenes. The upper half of it is painted to represent a sunset sky, and the lower half to represent moonlight. It is hung so that the upper half alone is visible. The scenery of the distance is then painted upon a separate piece, which is "profiled;" that is, the irregular line of the horizon made by trees, mountains, or houses, is sharply cut out with a circular saw. This piece is placed immediately in front of the sky drop. A few feet further in front is hung what is known as a cut gauze drop. This has sides and top of canvas painted as the case requires; while the center is filled with fine gauze, which lends an aerial effect to the distance. Red "mediums" are employed to give a soft, sunset glow to the scene. At the proper moment, the back drop is very slowly and steadily hauled up, while the red "mediums" are slowly turned off and green ones turned on. The moon is made in the night half of the sky drop, and rises with it. When it rises above the distant horizon the green "mediums" are turned on to their full power and the green calcium light is brought into play. The effect of this change, when carefully managed, is always very beautiful, and is sure to draw forth applause from the audience.

Moonrise, in a scene where there is no change from daylight to darkness, is often produced with a muslin drop and a "moon box." The muslin drop is painted to represent the sky, the clouds being painted on strips of canvas cut in the required shape and sewn on. The moon is made with a box on one side of which a circular hole is cut. Over this hole is pasted a piece of white muslin. A couple of wires serve to draw the moon upward. Of course the white illuminated circle shows plainly through the muslin sky, but disappears when passing behind the canvas clouds. By having another piece of muslin painted red and imperceptibly fading to white, placed at the back of the drop in the moon's path, the orb of night can be made to appear red at the horizon and gradually change to pale yellow as it sails slowly upward. Floating clouds are easily imitated by hanging in front of the sky drop a gauze drop upon which are sewn muslin or canvas clouds, and moving the whole slowly.

An ocean of heaving waters is made in this way: Each bounding wave is cut out separately. The first row is set up with a distance of three or four feet between each billow; and the second row is set so as to show in the openings left by the first. Small boys furnish the motive power. The waves are rocked back and forth, not from side to side; and the effect is very good. The noise of water rolling upon a beach is well imitated in a simple manner. A box of light wood is lined with tin. By putting two or three ounces of bird-shot into this and causing it to roll around the desired sound is produced.

Fire scenes are sometimes dangerous; but with proper care they may be rendered comparatively safe. That they are not so hazardous as is generally supposed by the uninitiated beholder may be learned from the following description: One of the most familiar fire scenes is that which occurs in the "Streets of New York," in which a three story house burns down, the roof caving in, the shutters falling, and the walls breaking with a wonderful appearance of realism. The house is painted on three separate pieces, the top one of which is swung from the flies; this constitutes the roof. Upon the second is painted half the wall, and it is joined to

the bottom piece in an irregular zigzag line. The simple dropping in succession of these pieces to the stage produces the falling of roof and wall. The fire itself is represented by chemical red fire and powdered lycopodium used separately, the former to give a red glow and the latter to represent flames. The shutters, which are to fall, are fastened to the scene with a preparation called "quick match." This is made of powder, alcohol, and a lamp wick. The window frames and sashes are made of sheet iron. They are covered with oakum soaked in alcohol or naphtha. These sashes and frames are not fastened to the canvas scene at all, but are placed a short distance behind it upon platforms. The quickest possible touch of flame ignites the oakum, and, in a moment, the fire runs around the sash, and nothing is apparently left but the blackened and charred wood. Steam is used to represent the smoke that issues from the crannies in the walls of the burning building; and an occasional crash, followed by the ignition of a little powder to produce a sudden puff of smoke, gives the spectator an idea of a falling rafter. Behind the entire scene is placed a very large endless towel upon which is painted a mass of flames. This is kept in constant upward motion; and, when viewed through an open window in the house, gives a good idea of the supposed raging furnace within. Add to these things a real fire engine on the stage, a host of yelling supernumeraries in discarded firemen's uniforms, and the spectator is easily filled with a sense of tremendous danger. Nevertheless the only flames upon the stage are those arising from the burning of lycopodium in a "flash torch;" and they are only allowed to blaze up for a second or two at a time. Fires in theaters resulting from a fire scene, are usually caused by carelessness in handling the powder which is used to produce puffs of smoke.

A DRAWING ROOM CORNER AND AN OCTAGON BOUDOIR.

THESE two interior views may be taken as specimens of the drawings with which Mr. R. W. Edis' forthcoming book on

THE PROSPECTS AND POSITION OF THE ARCHITECTURAL PROFESSION.*

By JOHN MCLACHLAN.

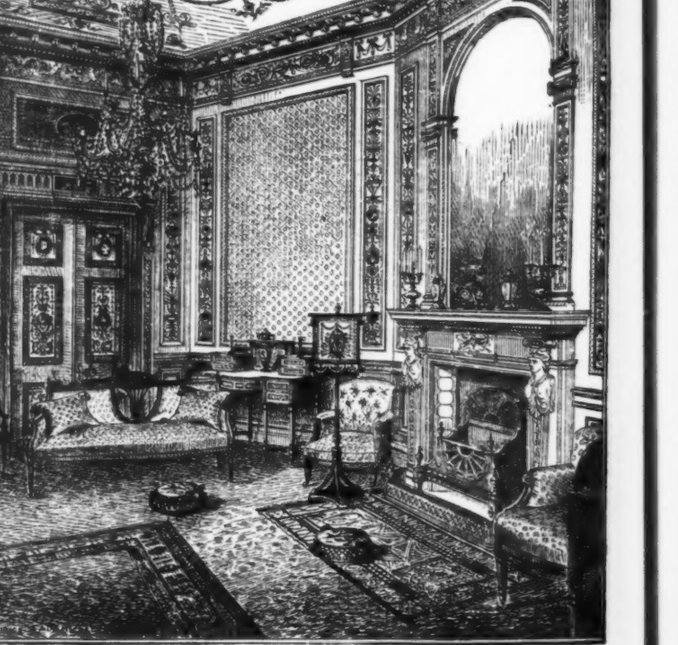
THE position and prospects of the architectural profession are of much interest to all of us. Whatever is derogatory to the dignity and honorableness of our calling; whatever in the conduct of any of our own members, or of others, tends to lower us in the eyes of the public; whatever obstacles stand in our way to professional improvement and advancement—all such considerations, hostile to our calling, will be naturally deplored; and, on the other hand, whatever tends to raise the status of architects, to elevate their position in society, to improve their opportunities of professional training, to encourage a cordial sympathy and fellow-feeling among the members—I say, whatever tends in the direction of these objects will naturally excite your approval. A general observation may be made which will find nobody bold enough to controvert. Within the last half century—in fact, within a much shorter period, an enormous stride has been taken both by our own and other countries in all that relates to art. Artistic ideas prevail now in regions where they were never dreamed of before. Furniture, dress, hangings, wall-papers, crockery, and a thousand other departments are regulated now by the same canons of taste which guide art in the longer acknowledged fields of architecture, painting, and sculpture. If we look around us for a moment, evidences of this truth crowd upon us. In the matter of furniture, for example, a glance at the windows of some of our best furniture dealers, or a visit to some recently furnished houses, indicates to us the greatest diversity of design in all articles of furniture—the healthy spirit of competition and emulation among the manufacturers, and the sound principles of design which, as a rule, guide them in their work. There is not now the depressing uniformity of design which pervaded the furniture of fifty years ago, nor the pernicious attempts of falsehood which consisted in making wood look like marble or stone. How often do we come across in the houses of 50 or 100 years ago, mantelpieces of mahogany, with pillars either Doric or Corinthian, fluted and carved with all the details of the Greek or Roman originals, including dentils, blocks, and egg and dart ornaments, or sofas and sideboards with elaborate, heavy, useless scrolls and details, copied—and not well copied either—from the marble work of the Temple of Lysicrates or the Tower of the Winds.

Contrast with such work, with all its pretentiousness and painful attempt to appear what it is not, and the utter poverty of design displayed—and be it remembered that this kind of stuff was all that could be got 50 years ago, there was nothing else to be had—I say, contrast this furniture with what we saw at the Paris Exhibition the other year, where, in obedience to the demands of educated taste, India, Japan, and all the realms wherein good and tasteful stuffs are produced, were called into play in the service of upholstery and house decoration; or indeed, contrast the furniture of our grandfathers with what we see in our best shop-windows now—and we have much reason to be thankful for the past and hopeful for the future. I venture to think that we find in furniture and house decoration a great advance. Simplicity of design, no desire shown to make wood appear any other material, no huge scrolls and other decoration where they are not needed, but the sound principles of construction which apply to wood carefully attended to, parts kept all in due harmony, a directness of purpose visible in making the article of furniture, whatever it may be, clearly and cleverly serve the object of its existence; and when ornament is applied, it is applied with reticence and good taste. The attention bestowed by architects on the whole subject of internal decoration has been so great of recent years that a fear has been expressed in high quarters, and from many sides, that if things proceed as they are doing, the architect will shortly merge in the house decorator, that in the devotion of his energies to designing sideboards, dadoes, dresses, carpets, and "cosy-corners," he will lose altogether the will and the power to design and carry into execution the larger, more masculine, and more important subjects which come within his professional scope. Aqueducts, bridges, sea-ports, terraces, gardens, fortresses, and viaducts on the Continent, are still within the architect's realm, but it is without doubt that they are so in this country. Without entering into the subject, which is a very important one, and one well worthy of prolonged consideration, of the transference of various kinds of work from architects to the comparatively youthful profession of civil engineer, the point on which I wish to press at present is the vast attention now bestowed on the tasteful decoration of buildings internally, on such matters as the color and material with which the walls are to be covered, the patterns of paper, the carpeting, and so on. There is a recognition of the canons of taste displayed by even the most careless of housekeepers on such subjects, which is greatly encouraging to those who have a love for art. Glass-staining is a subject which naturally claims our attention in this connection. It is a subject of great congratulation, I think, that good stained-glass is confined not to our churches and public buildings as heretofore, but has found its way into our private houses. In Edinburgh and other portions of Scotland, one is certain to find in the hall and staircase of our good houses, well-designed and executed stained-glass, giving an air of refinement and art which nothing else can give. A window is more potent as an artistic medium than any dead surface can possibly be. Obtuse people may ignore the beauty of a wall-paper, or the lines of a fresco, simply because there is no compulsion to look at them, but no person, even the most unnoticing, can fail to take cognizance of the stained-glass window of a hall or staircase.

The very use of one's eyes is dependent upon the rays which come through the glass, every article or object looked upon is tinged with the color of the medium—and perforce the attention of the most phlegmatic is called to the window. It is of vast importance, therefore a matter of great congratulation, that this important feature of a house is becoming more and more artistically treated. The universal arrangement for a hall or stair-window of 30 years ago, of a diaper-pattern of ground sheet in the middle, with ruby border four inches broad, with a Vitruvian scroll picked in the red, and with never-failing blue paterae at the corners, is rapidly

* Presidential Address, delivered at the meeting of the Edinburgh Architectural Association, November 17, 1880.

A DRAWING ROOM CORNER.



AN OCTAGON BOUDOIR.

SUGGESTIONS IN DECORATIVE ART.

"The Decoration and Furnishing of Town Houses" will be illustrated. These plates are here only slightly reduced from the originals, but in the book itself the drawings are smaller. —*Building News.*

THE NICE OBSERVATORY.

THE new observatory at Nice, which is being built at the expense of M. Bischoffsheim, will comprise at first two equatorials, one meridian, and several accessory instruments. One of the equatorials will probably be the largest astronomical apparatus in the world. Its focal distance will be 18 meters, and its aperture 0·76m. The cupola will have a diameter of no less than 22m. The construction of the object glass is intrusted to MM. Paul and Prosper Henry, of the Paris Observatory. The instrument alone will cost about 250,000*f.*, and the cupola will be correspondingly expensive. The total cost of the Observatory will exceed two million francs.

To remove wheel grease from woolen material without injuring the color of the fabric use good benzine.

dying a natural death. Such an arrangement is confined as a rule now to the semi-detached villas of speculative builders, whose object in building houses is not to produce anything beautiful to look upon, but simply, like the scissors-seller in the "Vicar of Wakefield," to produce an article that will sell. I do not say that the orthodox arrangement above described—with its red periphery—is an ugly one. It very often is not ugly; but the objectionable thing is, that it was a universal arrangement, indicating an utter deadness and torpor in the treatment of this important feature. Let us rejoice that the torpor has passed away, and that in the active application of well designed stained glass we are seeing the indication of more artistic times. In the recently-revived Queen Anne architecture stained glass and colored glass of various kinds play a very important part for the upper portions of windows, above the broad transom of wood or stone which is a common feature of the architecture. It is not the least likely that the Queen Anne style will take much root here. It is essentially a style suitable for brick, while our building material all over Scotland is stone—good freestone. The difference of material must and ought to exercise a vast influence on the designer. The lines and proportions suitable for the use of small rectangular blocks of brick are totally out of keeping with the more colossal proportions which are becoming with huge blocks of stone or marble. The style of design which is right and suitable and beautiful in the one case is totally out of keeping in the other. While this is so—I am quite satisfied that this exceedingly quaint style of building, with its thick astragals, lead lights and beautiful small and well-proportioned mouldings, will never come so far north to any appreciable extent—I think it a subject well worthy of attention whether we might not, in imitation of its love for stained glass, introduce into our windows, both of living-rooms and bedrooms, a great deal more variety and glory than we usually think of. In an architect's practice, here and now, after he fills a window of a dining-room or bed-room with the best British plate, one-quarter inch thick, or 21 oz. sheet, he thinks his duty is completed there. Now I think we might very well and profitably bestow a little more time and consideration than this summary procedure indicates upon our windows. Where light to the rooms is not of supreme importance, as, for instance, in a villa with no immediately contiguous dwelling, it might very well be considered whether a little stained glass in the upper sashes or borders might not be advisable. The feature is a very pretty one, and I see no reason why Queen Anne should have a monopoly of a feature which may be made to apply to all architecture. The improvements in all departments of industry where knowledge of the beautiful can be shown is undeniable. The source to which we more directly trace this great advance is naturally our schools of art. Our carvers in wood and stone, our engravers, our modelers, our designers for furniture, crockery, and ironwork, have all had their hands and eyes trained under able teachers, and with the best models of antiquity before them. Such schools are not confined to Edinburgh and Glasgow, but are to be found in all the important towns of Scotland. Their influence within the last 25 years has been enormous. All those of us who have undergone the training of such schools, can testify to the influence exercised by them on individual character. Brought in contact with the best work of past times, and under the tuition of able, energetic masters, whose hearts are in their work, if there is any latent art talent within us, any burning love for things beautiful, it is sure to take fire under such circumstances.

It is a subject of congratulation that, in addition to the numerous schools and lectureships of art throughout the country, we are now to have a chair of art in our Edinburgh University, the funds for which are insured by the provisions of Sir John Watson Gordon's will. This chair will, without doubt, give great impetus to all artistic subjects among us. It is not to be anticipated that immediate effects will appear. Rome was not built in a day, but the leavening influence of a professorship of art in an intellectual center like that of Edinburgh will soon render itself felt. This is our first professorship of art in Scotland, and it is to be hoped that the influence on a hard headed, close-fisted, metaphysical matter-of-fact people will be encouraging. We labor at great disadvantage in Scotland in all matters of art as compared with such favored countries as Italy, where the very air is laden with artistic ideas; where the common, blue-bloused workman will criticise you a work of Michael Angelo or Titian in no ignorant babble, but in good set terms. Or I might take an example from the cognate field of music, from an incident which happened under my own eyes in Florence. An audience composed of plain people, the burghers or shopkeepers of the city, at an operatic performance united in condemning a prima donna's bad note, and would in no wise permit her to proceed till after three attempts she accomplished the faulty note to their satisfaction. Such an incident is impossible in Scotland; we have no such artistic training here. The day is just dawning upon us.

In Italy the people have been under training in such matters for centuries. Art runs in their blood. The great men of their country, of whom even the common people are proud, are not so much their kings, their warriors, and their statesmen, but their architects, sculptors, and painters, their Tintorettos, Veroneses, Michael Angelos, Palladios. What a contrast this is to our Scotland! In a bleak, unfertile, rocky country our ancestors had enough to do to wrest a living from the sterile rocks. No time was theirs for the amenities of life, for those arts which render life worth living for, the painting, the sculpture, and the architecture. A better day is drawing upon us, the country is becoming, by the sturdy energy of her sons, more and more wealthy. The cultured leisured class are increasing in number, and the arts of peace are flourishing.

It is of the utmost importance that as we proceed in our race of artistic life, our taste should be wisely guided, that true canons of art should regulate us both in designing and criticising. It is from this point of view that the appointment of a professorship is of national importance. The prelections of the class-room will influence the whole people, stirring up thought, discussion, and controversy. Our national love for combat and metaphysics will find ample play in rival theories of art-opposing styles of architecture—different canons of taste—but contest indicates life, and as these subjects of art are discussed among us with more and more vigor and knowledge, the more does the subject itself become part of the life and soul of the people.

Having said so much on several incidents and features which seem to be entirely favorable to our profession, which appear to tend to consolidate our honorable position in society, and which tend to the enlarging and extending of our professional knowledge, it may not be out of place to take note of things which lower us in the eyes of the world, some characteristics of modern architects which do not raise them in the eyes of men. It is not wise to be too self-complaisant, to be perpetually singing pæans of self-gratulation over our progress. It is well to look in the mirror occasionally to see where stains and soiling are, so that a cleansing remedy may be applied to remove defects where they are found to exist.

Among the subjects affecting our profession which are perpetually cropping up in law courts or elsewhere, is that of commission. I do not mean, of course, the legitimate fee of 5 per cent., which is nothing more than fair remuneration for the arduous and responsible work of the architect. The commission which appears in so many lawsuits as being paid to architects is the surreptitious, underhand, disgraceful bribe applied by manufacturers, patentees, and other proprietors of building appliances to have their goods introduced into buildings. There can be but one opinion among honest members of our profession about this species of commission, and I think it is not unbecoming an association like this to set its face against such practices, which assuredly tend to disgrace our calling. The leaven of this corruption works in divers ways, and I think it is well that every upright practitioner should lend a helping hand to its exposure. One test is sufficient to blow all the plausible theories advanced for accepting commission such as I speak of into the clouds. If the architect will in plain words inform his employer that on the £100 roof which he has just designed he has pocketed £25 of commission irrespective of his fee, then, but not till then, I shall believe that the architect is acting as an honest man.

There are, however, other and grosser forms in which commission is sometimes taken, or in which I have heard it was taken, which only require to be mentioned to receive the hearty condemnation of such an association as ours. I have heard that some men calling themselves architects have in taking estimates so manipulated the offers of the tradesmen as to secure the work for creatures of their own; have so arranged the figures of the offers by opening them beforehand and adjusting them with contractors on whom they wished to confer the work, that large slices of emolument should be hidden in the estimates, ultimately to pass into the pocket of the architect. Such a form of wickedness—for it can be called nothing else—is little liable to become common unless among men who are bent on being rogues. It is conscious of its blackness and so keeps out of sight. Let us, then, visit with righteous indignation, wherever we find them, such mean and dastardly attempts to lower an honorable calling. As long as we accept and act upon the sound and healthy principle that the architect should in connection with his work receive *no remuneration whatever* except what he receives directly and immediately from his employer, there is no danger of our profession falling into disrepute. Let us act as upright men receiving no back-hand gifts or commissions or douceurs or bribes, and visit with exposure and contempt all attempts to the contrary mode of dealing, and I venture to think that in course of time we shall take a higher and more honorable position in society.

An aspect of this commission question presents itself which is of vital consequence to the outside public who employ architects. These members of our profession who live by their legitimate fees may often be twitted with the largeness of our recognized fee of 5 per cent., and be told that many practitioners work for less. I have no desire to lay down a hard and fast line on this point, and say that in some instances—such as in the case of large plain buildings, stores, or warehouses, where there are hundreds of pillars of the same dimensions, windows all the same, and so on—I say in such a case our fee may with fairness be modified very much. There is no possibility of laying down a hard and fast line of remuneration. Each case must be decided upon its own merits, and with a fair spirit on both sides—there is no danger of any serious collision between client and architect. But speaking generally, I am satisfied I am expressing the feelings of all architects who have been in business for any length of time that the ordinary recognized fee is as fair and moderate remuneration as could be stated. A less fee will not remunerate any professional man adequately, if he discharges his duty faithfully and energetically to his client. And it is here that this question of commission works mischief. Some architects offer their services for 3, 2, even 1 per cent. I have heard of some cases where architects offered even to work for nothing. I would warn all clients to look with much suspicion on such offers, because it is scarcely possible that the architect can be acting in good faith. He finds his fee inadequate, and inevitably betakes himself to devious ways of commissions and bribes from contractors to eke out his living. This is so palpable that it is astonishing the outside public who employ architects do not see it. But it is within my own knowledge that there are men belonging to our profession who habitually undertake work for a nominal fee to the client, but who make that same client pay the amount of three or four fees by manipulating the items in the schedules with the contractors in such a way as no client can detect. The thing is scandalous and disgraceful, and we cannot do better toward our profession than by denouncing such courses of procedure, and in our own practice, preserving clean hands. Depend upon it, honest, upright dealing will, in course of time, receive its due reward.

FLEUSS'S DIVING APPARATUS.

MESSRS. FLEUSS & DUFF have called attention, in a letter to the editor of the London *Times*, to the successful use of Fleuss's patent diving apparatus, in that part of the Severn tunnel which is now inundated: "The diver has succeeded in getting down the shaft, some 200 ft. deep, and then going a quarter of a mile up to the head of the tunnel, in order to close up the door so that the pumps might be enabled to clear the water out. After several unsuccessful attempts with the ordinary gear, we were applied to for our apparatus, and this was tried on Thursday, and proved a complete success, the diver easily accomplishing what had become an impossibility with the ordinary means of diving, owing to the great length of air tube necessarily required."

FRENCH LIGHTHOUSES.

ALL the lighthouses on the French coast, except three which are provided with the electric light, have been lit since 1873 with lamps burning mineral oil. The luminous intensity of the apparatus has been greatly increased, and notwithstanding the increase a saving has been effected of more than 400,000 francs ($80,000) per annum, or more than 30 per cent. of the cost of illumination with Colza oil. The use of the mineral oil has not caused a single accident in lighthouses, and after some trials it has also been brought into use for floating lights.—*L' Ingen. Univ.*

THE METRIC SYSTEM—IS IT WISE TO INTRODUCE IT INTO OUR MACHINE SHOPS?*

By COLEMAN SELLERS, M.E.

THE organization of a society of mechanical engineers offers a convenient and fitting opportunity for the presentation of the views of a mechanical engineer on the subject of the metric system to members of his own profession and to those who are similarly interested. During the month of May, 1874, I had the honor of reading before the American Railway Master Mechanics' Association a paper on "The Metric System in our Workshop: will its value in practice be an equivalent for the cost of its introduction?" In that paper I treated the subject mainly in reference to its cost. From what has since been published by those who advocate the enforced substitution of the metric system for the weights and measures in common use in this country, it is evident that the subject will bear to advantage a different treatment. I now propose to supplement the question of cost by an endeavor to show that the system, *per se*, is not so well adapted to the wants of machinists as is the one now in use, and that its enforced introduction will do harm to our industries in place of doing good.

In addressing to the members of the American Society of Mechanical Engineers arguments in opposition to any compulsory legislation in this direction, I feel that I am speaking to men who are familiar with the subject and who have already given thought to the results likely to obtain from the proposed change in the system. I feel too that I am speaking to those whose habit of thought fits them to consider the subject without bias. Mechanical engineers, of all men using weights and measures, are the ones most eager to adopt what in the end will be of the most use. To them weights and measures are not abstract ideas, but tangible substances. Engineers make the machines for weighing and measuring, and the result of their use of those machines exists as fixed matter, costing millions upon millions of dollars.

To the great bulk of mankind engaged in trade, in buying and selling, in bartering and exchanging, it matters little what system they adopt; it matters little whether they are obliged to use a yard-stick or a meter-rod, pounds or kilogrammes, quarts or liters. The cost to them of a change from one to the other is the cost of the few devices needed in weighing and measuring; the *rationale* of the system may never enter their thoughts.

With the machinist the case is different. He must not only possess costly means of measuring and weighing, with a degree of exactness unknown to others, but the results of these weights and measurements are fixed and unalterable. Enormous expenditures on tools, on drawings, on patterns, on everything he uses in making or building his machines, are on what is involved in the primary system used in determining weight and size. The product of this expenditure means everything that makes modern civilization possible. I propose, in this paper, to consider the subject only as it relates to our own profession; not in regard to its effect on the grocer, the drygoods man, or on the druggist. I propose to show why, after nearly twenty years' constant use of the metric system of measurement, I record my opposition to any enforcing legislation in this direction, because *the metric system is not well adapted to the practice of the machine shop.*

To render my arguments of any value I must endeavor to express myself so as to be understood by those who are not mechanics, and must crave the indulgence of my associates for dwelling, as I shall have to, on details so familiar to them, and for making my explanation of the usages of the workshop so elementary.

For nearly twenty years one large department of Wm. Sellers & Co.'s establishment has been worked on the metric system, as thoroughly as the system can be worked in any machine shop; as thoroughly as it is worked in France or Germany. The drawings made for this department are to the metric scale, figured in millimeters. The small tools and gauges are to metric measurement only, and the product of the shop is scaled to metric sizes and called by names based on those sizes.

During all these years, and for many years before, we have taken pains to inform ourselves, so far as lay in our power, as to all possible good to be derived from the system, in the drawing room as well as in the shop. We inquired into its defects and endeavored to overcome them by the same means as are resorted to in metric-using countries. The system is urged by theorists as a perfect system. All nations, we are told, should adopt it to bring about a desirable unity in weights and measures, even if all cannot be made to speak our language and all cannot be equally good and pious, as measured by some international scale of goodness and piety.

The metric system was legalized here in May, 1866. Some of its enthusiastic advocates now urge its being made exclusive and obligatory. Societies are organized to teach its principles to the people, and much money has been expended in publishing, but up to this time few conveniences have been placed in the hands of mechanics to enable them to use it in their calculations. Some years ago (the conditions remain the same to-day) letters addressed to leading publishing houses asking for metric books in the English language, equivalent to those to which we constantly refer, which books are as necessary to us as are our other tools, failed to bring a single favorable answer. What was asked for, was some book in which formulæ shall be given in the most convenient form expressible in relation to the metric nomenclature. Many books can be found urging its merits as a system, and the writers of these, in showing (?) that the metric system can be learned entire in, say, fifteen minutes, may think they have done what is needed, but no book yet published in the English language, so far as I have been able to learn, even approximates to what is required. We have nothing like the hand-books published in German. These Germans, in teaching their people, gave side by side in these almanacs of mechanics the formulæ expressed in Prussian inches and in meters. When the year 1880 came around they dropped the Prussian inch from these books when it was possible so to do. There are many very good books of tables for the ready conversion of the measurements of one system into the other, but unless an engineer is as familiar with the metric system as with his own they aid him but little. On the other hand, our English work books are many and valuable. The great bulk of literature of primary importance to mechanical engineers is in English and expressed in feet and in inches.

The absence of these help books need not, however, prevent any one *familiar with the metric system* from using it in his practice. If he can think in the new system he can work in it too. He can formulate what is directly needful to him if he will take the time and trouble so to do. The

* Read before the American Society of Mechanical Engineers, Nov. 4, 1880.

absence of these books has not prevented us from using it or familiarizing ourselves with it, and had it proved worth the effort, and possible, we would long ago have placed ourselves in position to advocate it, as none can knowingly do who have not tried it. In designing any engineering work, proportioned structures can be produced by either scale; the working drawings can be then made to whatever system obtains in the shop of erection. This change from one or the other system in the drawing room is a matter of no difficulty whatever. The change from one system to the other in the workshop, however, involves more than the usual advocates conceive of.

To show the measure of the misapprehensions as regards its effect on our profession, on the part of the enthusiastic advocates of the exclusive metric system, I will pass by some lesser lights and seek illumination from the central luminary.

Mr. Frederick A. P. Barnard, S.T.D., LL.D., who, besides being President of Columbia College in New York City, is also President of the American Metric Bureau, and of the American Metrological Society, etc., etc., said, Dec. 27, 1877: "It is now little more than a dozen years since the movement in favor of the reform of the confused metrological system of the United States was set on foot. Originating with a few *advanced thinkers*" (the italics are mine), "and regarded with indifference by the multitude, it encountered, as it is the fate of all efforts to emancipate mankind from the burden of traditional evils to encounter, a much larger degree of opposition than of encouragement or favor." Then, after denouncing many of those who oppose the forced introduction of the system (see page 279 and elsewhere in his Metric System), says on page 288 of the same book: "Among the arguments urged by those who maintain the impossibility of change only one appears to have much force, and that is the argument drawn from the dependency of machinery upon minute exactness in the measurements of parts and from the great expense which would attend the adaptation of machine shops and machines to a new system." Quoting the majority report of the Franklin Institute as to probable cost, and referring to the second report of the committee of the New York University Convocation, in which report the number of dimensions requiring separate indications on the drawings of a twenty-five-horse-power steam engine are given, he continues: "Singularly enough these statements and all the rest of the same class in both the reports referred to, instead of being arguments against the abolition of the present metrological system and the substitution of the metric for it, afford the strongest reason for believing that that is precisely the thing which ought to be done. We desire, I suppose, to create a demand for our steam engines and our manufacturing machinery on the continent of Europe. . . . But a steam engine or a machine, all of whose parts are measured in English linear measures, if transferred to a metric country and there, by accident, disabled, becomes nearly useless, *since the shops of such a country afford no facilities for repairing it*," etc. (the italics again my own).

It seems needless to tell engineers that these statements show so entire an ignorance on the part of Mr. Barnard of the merits of the case as can scarce be credited from such a source. I feel ashamed to tender to him an explanation of what is involved.

The unit of measurement used in making a machine does not in any way complicate the repairs of that machine. Machines built in England do not always agree with any of our even sizes, yet this discrepancy is a matter of no moment in the repairs of any of them. If we fail to find sizes corresponding to our sizes in English machines, presumably built on the same scale of linear measurement as are our own, neither do we find even millimeter sizes, always, in machines from France or Germany.

Wm. Sellers & Co. make injectors for feeding boilers. They make them to the metric scale. They were doing so some years before Mr. Barnard's "few advanced thinkers" went into the metrological reform business. Their instruments are made from drawings figured in millimeters in all parts, except where screws and screw-threads are needed. Screws to be cut on existing lathes cannot be conveniently figured metrically, unless we adopt the custom of some German shops to figure in one dimension and make gauges to some other one. A screw bolt in Germany called 25 mm. diameter must be made 25·4 mm. size to conform to the screw system in use there. It will have 8 threads per inch, and consequently 8 threads per diameter (I will explain this later). Screws cannot be metrically divided until metrically divided lead screws have been originated and put in the place of the inch-divided lead screws *common to all lathes in all parts of the world*.

The people into whose hands these injectors pass know nothing of the scale of proportions to which they have been made. If some piece need repairs and its shape has been lost by wear, it is needless to say that a knowledge of the scale would give no clew to that shape, but from some existing original any part can be copied; to copy requires no knowledge of the scale used. Repairs, too, as a rule, require deviation from the original size to compensate for wear.

While the value of the unit of measurement may be of little moment in repairs, it is, however, all important in the first production of machines. This leads me to another misunderstanding on the part of those whom Mr. Barnard classes, I presume, with his advanced thinkers; this cleared away will bring us to the position required in a judicious consideration of the two systems in their application to the machine industries of our country. I quote now from a pamphlet by Mr. Persifer Frazer; this pamphlet, says one of the Metric Bureau tracts, "contains more points, all well made, than any other of the same size on the subject." One of "the points" was suggested to him by the reading of a manuscript paper on the subject, said to have been written by an American engineer. The point made is this: "Lengths, breadths, thicknesses, capacities, and weights of things are related to the accomplishment of man's purposes, and are varied to conformity with the inflexible laws of mechanics for different motors, strains, and materials; no change of system will alter in the least their dimensions, though it may give them different names. . . . The grand truth of mechanics is, that the properties or dimensions of parts of machinery to accomplish any given purpose will be unaffected by any standard of length or weight applied to the part." This is a very good point, sounds well, but, as the facts are not *exactly* as stated, the point is a dull one. No workshop in the land is or can be equipped with minor tools and gauges for the production of all sizes by *infinite* gradations. The calculated proportions of machines, the sizes indicated by "the inflexible laws of mechanics," are sizes which must be made to conform to the nearest existing means of production and the merchantable sizes of the matter to be worked into shape.

In shop practice and in mercantile practice, to avoid an endless variety and confusion of sizes, certain dimensions in progressive order are adopted, being the sizes found most useful and most *salable* in practice. These progressive sizes we may call, in order to make the matter easily understood by "advanced thinkers," *shop sizes* and *merchant sizes*.

It is by the use of well-considered ranges of shop and merchant sizes that the maximum of convenience is obtained at the minimum of cost. Hence one metrological system may be found to possess advantages over another when put to the test of practice. The one that is best in affording the most convenient and the most easily used and *memorized* series of sizes should not be called unphilosophical.

The resting place for memory in the American series of shop sizes is the inch. The inch is subdivided by a process of repeated halving down to $\frac{1}{64}$ in the usual grade of shop and merchant sizes, as in bar iron. This gives 16 sizes to the inch for small sizes; 8, 4, 2, or 1 to the larger sizes.

If a machinist should order from us a set of caliper gauges from $\frac{1}{16}$ up to 2, advancing by $\frac{1}{16}$, and from 2 up to 4 advancing by $\frac{1}{8}$, we are at once informed of the shop system contemplated in his workshop.

Calculations based on the "inflexible law of mechanics," as read by *finite man*, intimate for the size of a certain part of some machine a dimension 3·95 inches diameter; the prudent engineer has possibly assumed a sufficiently ample *factor of safety* to permit him to select $3\frac{15}{16}$ inches, the nearest shop size below the theoretical size; $3\frac{15}{16}$=3·9375 inches. He desires to use this shop size, because 4-in. iron, an obtainable merchant size of bar iron, will clean up from the black to this size; but if his dimension relates to castings or forgings he may select 4 in. as a shade stronger.

Metric-using people have ranges of shop and merchant sizes too; when I come to compare their possible series and their actual series with our own, some faint glimmer may come to those who now know nothing about the matter of the fact that our unphilosophic system is not so very bad after all.

In regard to what is involved in each shop size, in a money point of view, I will give but one single example. The inquiry to our own tool-room keepers for a list of the separate devices used in producing one size, viz., $1\frac{1}{4}$ in., brings to me the names of 129 articles or sets of articles, such as drills, reamers, gauges, boring bars, and cutters, taps of all kinds for all sorts of uses, hardened mandrels, etc., etc. These many pieces, costing many hundred dollars, represent one size only. They tally with and belong to the dimension marked $1\frac{1}{4}$ in many thousand pieces on drawings, which have been accumulating for years, to patterns loading down our pattern lofts, to gear wheels interchangeable over a continent, and to the output of our factory for years. So important in an economical point of view have come to be these shop-size series, that machines built in one shop, if to be reproduced (not repaired) in another, must be redrawn to conformity to the shop system in use before the work can be begun to advantage. Year by year this harmony in shop sizes in America spreads over a larger area. Entire harmony in essential points exists in many of the leading shops. There are, however, examples still to be found in which machines built in one shop have no dimension in common with the shop sizes we use, as compared to our inch series or our millimeter series, *for we use both*. The expert recognizes such machines as having been built to gauges varied by the judgment of the master workman, or by the more *costly* method of fitting one piece to another already completed, a process not admissible in any well-regulated machine shop.

A good workman may by hand construct, we will instance, a sewing machine. He will alter and try, and rearrange its parts until he has satisfied himself with the result. He may not have scaled this machine to any system. It goes to the manufacturer, who must, perforce, change some of the wild-cat sizes to conform to merchant sizes of the material to be used. For the rest he may be content to fit gauges and templates to the model and reproduce it in minute exactness. We recognize, however, in every well-arranged series of shop sizes, and in the means employed to *maintain size*, the highest value of possible *merchantable* good workmanship, for in such possibilities we recognize economy in tools as well as in work, in interest on capital and in wages. This system has been growing year by year in spite of our so-called unphilosophic metrology. Eli Whitney, in 1798, gave a lesson in this direction when he began to make muskets with interchangeable parts in Springfield, Mass., but it was not until 1855 that the English government recognized what Whitney had done by importing American gun-making machinery. Since Whitney's time, the standard system has been carried into all branches, not only of our own trade, but into all the requirements of other trades as well.

The metrology of the American shops is based on the inch, and on it only. This dimension is cut up into minor parts by halving to any degree of subdivision, practically in shop sizes to $\frac{1}{64}$; it is also divided into 10 parts and into 12 parts when such divisions serve any good end. All such divisions have their uses and lead to no confusion. The inch squared is the base of our strains and pressures. The inch cubed gives us capacities. Later, I will speak of 12 and 36 inches squared and cubed. This one unit, the inch and pound weight of 7,000 grains troy, is all that a machinist needs to carry on his business. His inch is the same inch as is used in England and in the Russian machine shops. His pound is the pound in common use in England.

In America we have dropped some needless weights and measures, just as we have seen fit to drop the letter *u* from some of our words. We do not use in the machine shop the ton of 2,240 lb., nor its quarter or its hundredweight; we do use a weight called "ton of 2,000 pounds." This is the factor weight in strains, and by it we sell machinery. Other trades may retain some of these useless things; I am speaking only of machine shop practice.

The unit of measurement in France and in Germany is the *millimeter*. It is not and cannot be the meter, for the following reason: The great majority of all sizes used in the construction of any machine, whether it be big or little, are less than one meter. By the use of the millimeter only, decimals are avoided. Eight millimeters must be written 8 in the millimeter scale, while it must be written 0·008 in the metric scale. This is reason enough, for by the use of millimeters only, confusion of signs is avoided, and the *danger incident to decimals* is also avoided; hence *all* drawings are figured in millimeters only, up to dimensions measuring many thousand millimeters. This little dimension is then squared and cubed, or ten or a hundred millimeters are squared and cubed, for the uses corresponding to our squared and cubed inch and foot. As may be expected, happy coincidences of conveniences are found in either system. Thus an ardent metric advocate instances that 1 kilo to the square centimeter is just one atmosphere. We say 15 lb. to the inch is an atmosphere. Neither one is right, but the 15 lb. to the inch is 1 per cent. nearer right than the other is. For a machinist who seldom uses atmospheres a happy coincidence on the other side will be of more service. It so happens that wrought-iron bars with parallel sides measure in square inches of this section just one-tenth of their weight in pounds per yard. Now, inasmuch as "shapes" in iron are rated by the pounds per yard, for convenience in large structures, so it comes to pass that, when we know the weight per yard of any wrought-iron "shape," we know at once its sectional area. Inasmuch as compression and extension and factors of safety are involved in a knowledge of cross section, it is handy to be able to find it so readily, is it not? A shape iron 80 lb. to the yard has 8 square inches area of section. If it is good for 10,000 per square inch in extension we may load it with 80,000 lb.

I have set out to compare the two scales—to compare the two units rather, after an experience of twenty years with both. The inch is 25·4 times larger than the millimeter. These are the two dimensions we are to compare.

We will begin in the drawing room. Here "the inflexible laws of mechanics" find their first expression in form on paper. Few machines, or even parts of machines, can be drawn full size. Hence comes the need of "scales." There is reason in all things, even in scales. The unwritten law of most machine shops is to make every drawing as large as possible, as near full size as the nature of the subject and the dimensions of the paper used will permit. We have in our drawing room about 125 drawers, each of which will take in, without folding, drawings 52 inches (1,320 mm.) long by 33 inches (840 mm.) wide. This is about as large a sheet as we can use to advantage, and tracings from these are not unmanageable in the workshop.

For metrical drawings we can use the following scales *only:*

Full size in which 1 mm. = 1 mm.
One-half size in which ½ mm. = 1 mm.
One-fifth size in which 2 mm. = 1 cm. or 2 cm. = 1 dm.
One-tenth size in which 1 mm. = 1 cm. or 1 cm. = 1 dm.
One-twentieth size in which 5 mm. = 1 dm.
One-twenty-fifth size in which 4 mm. = 1 dm.
One-fiftieth size in which 2 mm. = 1 dm.

Down to the one-tenth scale the dimensions can be read from a good millimeter rule, for the one-twentieth, the one-twenty-fifth, and the one fiftieth scales must be constructed. The jump from one-half to one-fifth size is unfortunate. Could we conveniently quarter the whole size we would have an increased area section, a matter of much moment. The ½ of 10 inches is 2 inches, and the square of 2 is 4. The ¼ of 10 inches is 2½ and its square is 6¼, a gain in size of over 50 per cent.; a gain in comfort, in convenience, and in eyesight. Here we catch the first glimpse of the advantage of our own system; for with it a draughtsman can, from an ordinary well-divided inch rule, obtain the following scales: Full ½, ⅓, ¼, ½, ⅙, ⅛, ⅒, 1/12, 1/16, 1/20, 1/24, 1/32, 1/40, 1/48, 1/64—12 gradations, as compared to 7, and to these 12 can be added with perfect ease 5 of the others, making 17 in all, if the preference be for the decimally-divided inch, a scale carried in the tool-box of every machinist, and obtainable from the two-foot rule in so common use.

The scale series in most common use is that of ½, ¼, and ⅛; this halves down from whole size, and can be raised, in rapid drawing, by taking off diameter sizes from one drawing and using them as radius dimensions in the other, a process impossible between ½ and ⅓ sizes.

The true value of this extended series of scales, with its peculiar advantages, is manifest to any one familiar with both, *and admits of no dispute*. Is it a wonder that draughtsmen brought up under a metric rule take so kindly as they do to our unphilosophical system?

Drawing is but a small part of the engineer's work. More or less calculating has to be done; many hours must be spent in figuring strains, estimating weights, determining speeds, and what not. This brings us to the test of convenience in calculation, to the stronghold of the metric advocates. It is just here that Dr. Edward Wigglesworth in his metric tracts comes out the strongest in his peculiar style. He says that Americans, self-ruling, are really too lazy, while merely claiming to be too stupid, to use the system. He says: "Shame on a country which to party gives up what was meant for mankind." It is claimed that the decimal notation of the metric rule gives great facility in calculating, but that this is not its sole advantage.

Mr. Frazer says: "Let the carpenter or mason be asked how many tons of water a structure, whose *external* (I guess he means *internal*) dimensions are given, by his rule, will contain, and they will acknowledge that the decimal division is not the only advantage of the metric system, but that another is the perfect relation of extension, capacity, and weight." For a structure 5 feet square and 10 feet deep the carpenter would divide, in his head, 250 by 32, and say 8 tons, nearly, or 7·8125 tons exact of the tons of 2,000 lb. in use in all such measurements. The metric system would give for a nearly similar structure, say 1·5×1·5×3 meters, a result obtained by multiplying only; but what then? This problem applies to water only. If these spaces were to be loaded with bricks the metric multiplication must be still further multiplied by the specific gravity of bricks, thus: 1·5×1·5×3×1870=12,622·5 kilos, while our mason's sum would read 5×5×10×125=31,250 lb. of common hard bricks, with an ease of calculation rather in favor of the two-foot rule.

I have mentioned the innumerable books which have been prepared, simplifying processes of calculations by tabulating the results of experiments on a basis of the inch unit. Of these books the English experiments form a large bulk of the valuable engineering knowledge of the world. Hodgkinson, for example, experimented with the crushing resistances of various substances, and the results of his experiments are in the possession of all engineers. He took examples in cylindrical form, 1 inch diameter, 2 inches long each, for these experiments. Armengaud quotes these experiments and tabulates the results, saying they were obtained by Hodgkinson, *avec des cylindres de* 0·0254 *de diam^tre sur* 0·508 m. *de haut*=1"×2", and from these he deduces, for example, that *ash* has a crushing resistance of from 610 to 653 kilos per square centimeter.

Mr. Trautwine, quoting Eaton Hodgkinson's experiments, also tells us that ash, weighing from 45 to 53 lb. per cubic foot, has a crushing value of 8,600 lb. per square inch. Now, 1 lb. per square inch = 0·0703077 kilos per square cm., or 1 kilo per square cm. = 14·2232 lb. per square inch, $\frac{8,600 \text{ lb.}}{14·22}$ = about 605 kilos to the square cm. Here, from Trautwine's deduction, the metric-using engineer will employ 605 as a factor where we use 8,600 in the same case. He, because his unit of measurement is less, or, rather, requires more figures to express it, multiplies these many figures by a lesser factor, while we, expressing our dimensions with lesser figures, use with these figures a larger factor. In other words, we can complete our calculations sooner because we

are able to deal with the largest measures compatible with convenience. We can use the cubic inch, the cubic foot, or the cubic yard at our pleasure, just as the mechanic selects his tools in accordance with the extent of his work, and don't fool time away driving at a railroad spike with a tack hammer.

I have before me, as I write, French books and German books on mechanical engineering. In some, both French and German, all or nearly all formulas for strains are expressed in kilos per square cm., while Prof. Reuleaux, in his many valuable books of reference, seems to adhere to kilos per square millimeter. Now, to test the matter of convenience, in a way familiar to all mechanical engineers, let us go to Reuleaux for our information as to the strength of cast iron in the familiar equation for beams of $W = \frac{4\,s\,b\,h^2}{l}$. Reuleaux says the value of s may be taken as 4 kilos per square mm.; this equals 400 kilos per square cm., or 5,689 lb. per square inch. Let our example be a cast-iron beam of rectangular section, 9 inches deep, 4 inches wide, and 10 feet between its supports; given, to find its safe load in the middle. Let us round up these dimensions into a somewhat similar beam, measured in mm., $230\times100\times6\,000$. Now, h=230 or 9, b=100 or 4, l=3,000 or 120.

The formula then reads:

$$\frac{4\times4^1\times100\times330\times230}{6\times3,000} = 4,702^1 \text{ for all dimensions, in mm.}$$

or

$$\frac{4\times400^1\times10\times23\times23}{6\times3,000} \text{ for all dimensions, in cm.}$$

If we take 6 from the denominator, then

$$\frac{4\times66\cdot6\times10\times23\times23}{300}.$$

If we make the formula good for cast iron only, and use centimeters in the numerator and meters in the denominator, which is the best we can do,

$$\frac{2\cdot664\,b\,h^2}{l} \text{ for cast iron} = \frac{2\cdot664\times10\times23\times23}{3}.$$

Compare this with $\frac{4\times5689\times b\,h^2}{6\,l}$ which reduces to

$\frac{316\,b\,h^2}{l}$ for cast iron, and reads $\frac{316\times4\times9\times9}{10}$

My note books are full of such examples as this; it has been my wish to test this matter thoroughly; my experience covers many examples of engineers and draughtsmen educated in metric-using countries, who, when they come to us, learn to use our measures as quickly as we can learn to use theirs, but adopt our methods of calculation as involving fewer figures. Thus, for all practical purposes, in strains, what will be strong enough in kilos, if we assume two pounds to the kilo, will be near enough right, and if the "grand truth of mechanics is that properties or dimensions of parts of machinery to accomplish any given purpose will be unaffected by any standard of length or weight applied to the parts," it is therefore possible to arrive at the theoretical proportion by either system, and it is presumable that the workmen will select the easiest one to work with, the more so if the easiest one happens to be the one he has been most used to. I have yet to see the example of a metric-educated draughtsman working in millimeter calculations on an inch-measured machine, while with our own experience with both we could follow him in either.

Cubic inches go farther than cubic millimeters, *i. e.*, they involve fewer figures in their expression; because a cubic inch is 16,000 larger than a cubic millimeter, it is 16 times larger than a cubic cm.; and while, again, the liter is, may be, 64 times larger than the cubic inch, yet is the cubic foot 27 times larger than the liter, and between the liter and the cubic meter there is no unit of measurement; 10 liters, like our gallon, has an edge only expressible in decimals.

The harmonious relation of extension, bulk, weight, and all that comes out strongest when we deal with distilled water. Away from that precious fluid, and we are required to know and use the weights of matter as they relate to water. I must confess I see no difference in favor of hunting up in books the specific gravity of matter, or in looking for the weight of matter in pounds per cubic inch, or foot, or yard.

With distilled water engineers have little to do; when they note the solid matter accumulating in their boilers, they wish they had more to do with it. In hydraulic calculations the weight of distilled water, however, may be near enough to the weight of the water they have to deal with to enable them to reap all the advantages desirable from the system, did not the small units, the millimeters, or the many figures in the decimals of the meter, mar the result in a labor-saving point of view.

The value of the drawing-room system is tested or tried when the drawings reach the machine shop. It is there that errors are found out. An incorrectly figured drawing costs nothing on account of the errors so long as the drawing rests quietly in its drawer; but it costs fearfully when the error is discovered in the partially finished machine. All engineers agree on one thing, viz., the fewest possible figures that can be used to express dimensions clearly, the easier it is to work to the drawing, and the less liability to make mistakes. Beautiful as is a decimal system in calculation, and we all use it, save in mental arithmetic, it has been found advisable to avoid the use of decimals as far as possible on the drawings used in our workshops, even in metric-using countries. A misplaced point is an easy error to make, and may cause no end of trouble and expense.

I had hoped for gain in the drawing room from the use of metric scales; I expected to find more than in the machine shop; I have been disappointed in both.

In the machine shop we come to test the value of shop sizes and merchant sizes, or rather the series possible in both, with one or the other system. For what is in use abroad, we look to Germany rather than to France for information useful to us, inasmuch as in Germany the metric system was taken up at a late day, and was introduced in its entirety without shock. To united Germany anything was better than their frightful confusion of 15 inches in use, all differing from the inch still used with their screw threads, and differing from the inch of England. The metric system is incomparably better than their before entire want of any uniformity. With us the matter is very different, as will be seen more clearly as we advance. We divide our unit, in practice, into just what parts are best suited to express our practical wants, and the system in our machine shops is uniform over a continent.

The first item of manufactured matter entering the machine-shop door is bar iron. The merchant sizes of round, square, etc., in America, are by $\frac{1}{16}$, by $\frac{1}{8}$, by $\frac{1}{4}$, etc. In Germany, similar bars advance in size by 1 mm. up to 40, by 2 mm. from 40 up to 80, and by 5 mm. above 80. This system is memorizable by 40 and 80—by 1, 2, and 5. It is the best that can be done with a system tied up to an unhalvable scale. It does not agree with the English or American merchant sizes except in a few sizes. The system of bolts, diameters, and threads per inch common or general over the continent of Europe is that known as the Whitworth system. They still adhere to this system, as they do to the English system of gas and steam pipes and their fittings. The Whitworth system pitches its threads to even numbers or half numbers per inch in length. These pitches are easily obtained from the lead screws of all lathes, which are 2, 4, or 6 threads per inch as a rule. Having given up the inch, the Germans formulate their threads per diameter (see tables at the end of this paper). For the names of the bolts, they must either retain their English names, and call a 25·4 mm. bolt one inch, or they must call it what it is, 25·4 mm., but some call it 25 mm., and make it 0·4 mm. larger. This inch bolt has 8 threads per inch, and, as the diameter, too, is 1 inch, it can be said to have 8 threads per diameter. A $1\frac{1}{4}$-inch bolt measures 28·6 mm.; it may be called 29 mm. size; it must be cut out of 29 mm. iron, the nearest merchant size, with a loss of $\frac{1}{10}$ of a millimeter. This loss don't seem much, but the dies which have to cut it off tell the story very soon. The Whitworth scale gives the same pitch to $1\frac{1}{8}$ and $1\frac{1}{4}$ screws, viz., 7 per inch. The exclusive metric shops call the one $7\frac{1}{8}$ threads per diameter, and the other $8\frac{1}{4}$, and yet they are practically the same and must be cut with the same combination of change wheels on the lathe. Here is a precious example of what comes from trying to harmonize two systems under one nomenclature. The screw system in general use is so good, it has been so long in use, its disturbance would shock so many interests, that it is unwise to give it up, as unwise as it would be to adopt the American gas-pipe system in place of the English, or for us, if for sake of uniformity with England and Germany, we should attempt to force the adoption of their system into our houses.

Imagine the hue and cry if some "benevolent despot," for the good of mankind in general and Europeans in particular, should direct us to change our "fittings" to English standards, none of which would fit the pipes we have in our houses. Why, we are even vexed enough if we are sold a "sleeve" which will not fit a pipe put in place thirty years ago.

America has, for the last half century, been striving in its own way toward equalization of its standard sizes. The immense railroad industries demand this. Standard wheels on standard axles—standard fitsizes for both—are all founded on an inch scale of sizes.

Standard shafting for mill gearing gives a good example. It has been demonstrated that bars carefully rolled to size in rounds can be reduced to turned shafting with the loss of $1\frac{1}{2}$ mm., or $\frac{1}{16}$ inch to the diameter. Hence, bars 2, $2\frac{1}{4}$, $2\frac{1}{2}$, $2\frac{3}{4}$, 3 inch, etc., are made into shafts $\frac{1}{16}$ less in diameter, sold by their full size names, *i. e.*, by the name of the iron from which they have been made and designated by the affix "shafting size." A 2 inch shafting-size bar measures $1\frac{15}{16}$ inch, and a pulley ordered to-day with an eye to fit a $2\frac{1}{2}$ or a 4 inch shaft made thirty years ago will be found to be to size. Now this American shafting sells freely in Europe and no one complains of its size. He can command the markets of the world who can make the best machinery at the least cost, and that machinery will be taken and used and no questions asked about its inches or its millimeters.

A scale of shafting sizes so uniform and so easily expressed by $\frac{1}{4}$ up to $3\frac{1}{2}$, and by $\frac{1}{2}$ inch to sizes above 3 is met in metric countries by the ease of an advance by 5 mm. only. To obtain the economy of American shops their shafting sizes should be $1\frac{1}{2}$ mm. less than their name, *i. e.*, a 100 mm. shaft should be made $98\frac{1}{2}$ mm. diameter, but the Germans have seen fit to retain even sizes, and are thus obliged to use 57 mm. iron to make a 55 mm. shaft, and 93 mm. iron to make a 90 mm. shaft, while on still larger shafts they must be content to lose 5 mm. at each turning. Such is the usage now, so far as we can learn.

The shop sizes in America harmonize with the merchant sizes and with convenience. We cannot change them. It would be unwise, I think, to do so in face of the obtainable metric sizes if we could. One other example of good and bad systems, and I have done with this part of our subject.

An essential of all machine shops is a drill system; a series advancing by $\frac{1}{16}$ up to 1 inch, and by $\frac{1}{4}$ inch up to 2 inches is equivalent to an advance by $1\frac{1}{4}$ mm. in a metric series. Such an advance as $1\frac{1}{4}$ mm. is impracticable, because it must be memorized entire; it affords no holding place for the memory. Twist drills were first made in America; they were so good, so useful, that American drills came to be the rage in Europe. After a time good makers there began their manufacture. I will mention one house, founded in 1834, that of Heilmann, Ducommun & Steinlen, at Mulhouse (Alsace), one of the best known houses in all Europe. They make twist drills from 10 mm. up to 50 mm., advancing by 1 mm., but their price list tells us that the sizes marked in bold-face type are the sizes in use in their own shop. These sizes are: 10, 12, 15, 18, 20, 23, 25, 28, 30, 32, 35, 37, 40, 42, 45, 47, 50. Here a series of sizes approximating the English ones is adopted, but it is a series which must be memorized entire, as its advance is not by two or by three either, in regular sequence. We cannot question the wisdom of the men who have selected these shop sizes to meet their known wants; they rank too high as workmen, they know too much to challenge criticism. Doubtless, this scale of sizes is about the best they can do with the metric system; we would not tie ourselves to it. I could continue the list of practical difficulties until I had filled a volume. They run through the entire list of all that goes to make up the requirements of our profession, and show how unwise we would be to change, if we could do so for the sake of harmony with Europe. We have not adopted the Whitworth system of screws in America, and yet, by so doing, we would place ourselves in harmony with all Europe. We recognize objections to the system, and when those objections were clearly pointed out by Mr. William Sellers, and he proposed a system free from the objections, his system was accepted by the committee of the Franklin Institute, and then by many departments of our government. Had the metric system shown itself to be the perfect system it is claimed to be, it too would have been taken up more generally at a time when it was easier to have done so than now.

The American mind is quick to note what is to the advantage of American mechanics. We take up quickly what is good to hold to, and we will not accept what we have demonstrated to be less useful. This was made manifest to Prof. Reuleaux, Director of the Industrial Academy, Berlin, and is expressed by him in his report on motors and machines at Paris Exposition, 1867. In commenting on the many novelties from America, he says: "Upon the whole, it may be said that in machine industry, England has partly lost her formerly undisputed leadership, or that she is about to lose it. The healthy young transatlantic industry, which continually withdraws from us energetic and intelligent heads and robust hands, makes with the aid of her peculiar genius, the most sweeping progress, so that we shall soon have to turn our front from England westward." Then, in commenting on the rapidity with which American ideas were finding a home in Germany, speaks of the genius for inventions of this kind as peculiar to us: "They are distinguished from us by more direct and rapid conception. The American aims straightway for the needed construction, using means that appear to him the simplest and most effective, whether new or old. . . . The American really constructs in accordance with the severest theoretical abstractions, observing on the one side a distinctly marked out aim, weighing on the other the available means or creating new ones, and then proceeding regardless of precedents, as straight as possible for the object. . . . This spirit is strikingly prominent in the (Wm. Sellers') system of screw threads which he has boldly placed alongside of the old venerated Whitworth system, in spite of the terror of its numerous adherents, after he had discovered actual deficiencies. A proper valuation of this proceeding contains the most instructive hints for our higher technical institutions."

There is an irreconcilable discord between the inch and the divisions of the meter. The inch has become fixed to a greater extent in dollars and cents, in fitness and convenience, in this country than in Germany, and yet there, in some cases I have shown, it cannot be given up. To keep our scale of sizes and use French dimension sizes would "furnish a precious example of the simplicity of the decimal system. I was a signer of the majority report of the Franklin Institute which opposed the compulsory adoption of the metric system. That report was prepared and written by the chairman, Mr. Wm. P. Tatham, since made president of the body which adopted it as their view of the matter. Mr. Tatham is a man of culture and a hard student. His business as maker of lead pipes would have been less affected than that of almost any other manufacturer by the introduction of the metric system. He said, and I subscribed to the statement, that he believed that the ultimate benefits of the change proposed would be of less value than the damages during the transition. This was on the supposititious view that ultimately some would be benefited. As an engineer I can see no possible good to come to American machinists from the change. Its introduction exclusively would not diminish his labor in any way; it would not cheapen his product, it would increase its cost. It is, in fact, however, so impossible in view of existing matters and existing harmony in interchangeable matter, that should the metric standard be made the only legal standard in America to be used in buying and selling, the engineering establishments now in existence could not heed the law, but must perforce use their existing tools and gauges of precision, and continued to make material in conformity with existing matter.

The metric system was admitted here to an equal fostering in point of law in 1866. It had not been legalized in any way when we, for good reasons, introduced it into our own workshop in Philadelphia, and yet, at that time, we asked no one's permission to do what we pleased in the metrological management of our own business. We had a chance to try the system in making something which did not clash with existing merchant sizes; once having perfected an organization in this department we became fixed in its continuance. Precisely the same reasons why we cannot change our general system into the metric hold against our giving up the metric system in the departments where it is in use.

If the change to the metric system will aid commerce, let the merchants do as we have done—try it. Commerce depends, in a large measure, on the possible output of our workshops. The engineer controlling the workshop, and who, to be successful, must be a merchant, too, knows too well how he stands to give up a practically useful system more convenient to him after having tried both, for the sake of any fancied conformity with other countries. He can give up no vantage ground. His success in his life-battle in these days of active competition depends upon wise economies to enable him to prosper. He has no more reason to cripple himself with an inconvenient system of metrology than he has to give up a tariff of protection on his production in order to make it easier for the world to compete with him.

I am tempted to touch on the educational view of the subject, but will content myself with very few words. When engineers are told that the change to the metric system would save two years, or one year, in the school life of every child, they ask how many years are now devoted to mathematics only, in the average four years' schooling of the mass of our boys, and ask: What is to be lopped off to make this saving? Many a good workman who has risen to a high rank among educated mechanical engineers had too few years at school to admit of a month's saving in any one branch of his studies.

It is the thing just now to favor the change. A young engineer enlisting himself in the ranks of the metrical reformers (?) buys a cheap scientific notoriety. He is brought into sympathy with the self-constituted advanced thinkers. Those who oppose the change, after having become familiar with both, are said to "sever themselves from the congenial sympathy of the enlightened public opinion of to-day." The mechanical engineer can accept nothing as true until he has demonstrated the truth by experiment, at least, in anything capable of being put to the test of experiment. It is in the power of any intelligent man to test the metric system as others have done. He will, I think, find that the *savants* who originated the scheme before mechanical engineering, as it now exists, was known as a profession, made the mistake of beginning at the wrong end, and by the time they had cut it up or down to human wants it came out less fitted to human requirements than if they had recognized in the beginning the needs of the beings who were to use it.

Our metrological reformers urge us to adopt a new system in place of our present one, a system that harmonizes in no way with anything we now use. This new system is practically based on a certain measure over 39 inches long. This is cut up into 1,000 parts, and 100 of these parts cubed gives their primary vessel of measurement. The contents of this vessel in distilled water under certain conditions is their pound weight. Had the English yard of 36 inches been so treated it would have been as good a system, but no better. It would have been as inapplicable comfortably to our profession as is the metric. The wonderful extension of the metric system to time and infinite space was given up as impracticable long ago, and we are now asked to bear the shock of a mighty change to use this *inconvenient* system, this unhandy system of ten, for the sake of uniformity with some other peoples of the world.

In conclusion, when we take into consideration the enormous interests involved in manufacturing in America; if it is, as we think, unwise to tamper with the existing metrology of our workshops, the question may well be raised as to the wisdom of enforcing the metric system in trade generally. The practical mind of Americans has already dispensed with much useless stuff, coming to us with our old metrology; is it not better to continue to amend what we have, to encourage the uniformity so desirable, rather than to attempt to make all things new; but in no respect practically better, at so frightful a cost?

WHITWORTH'S SCREWS.

In use in Europe, especially in Germany.

Diameter. English inch.	Diameter Prussian inch.	Diameter. Millimeter.	Diameter at root of thread English inch.	No. of threads per diameter.	No. of threads per inch. English.
¼	0·248	6·4	0·186	5	20
5/16	0·303	7·9	0·241	5 5/8	18
⅜	0·364	9·5	0·295	6	16
7/16	0·425	11·1	0·346	6 1/8	14
½	0·486	12·7	0·393	6	12
9/16	0·607	15·9	0·509	6 7/8	11
⅝	0·728	19·0	0·622	7 1/2	10
11/16	0·850	22·2	0·733	7 7/8	9
1	0·971	25·4	0·840	8	8
1 1/16	1·092	28·6	0·942	7 7/8	7
1 1/8	1·214	31·7	1·067	8 1/4	7
1 3/16	1·335	34·9	1·162	8 1/4	6
1¼	1·457	38·1	1·287	9	6
1 5/16	1·578	41·3	1·389	8 1/4	5
1⅜	1·700	44·4	1·494	8 3/4	5
1 7/16	1·821	47·6	1·591	8 1/16	4 1/2
2	1·942	50·8	1·716	9	4 1/2
2 1/16	2·185	57·1	1·960	9	4
2 1/8	2·428	63·5	2·180	10	4
2 3/16	2·671	69·8	2·384	9 5/8	3 1/2
2	2·913	76·2	2·634	10 1/2	3 1/2
2 1/16	3·156	82·5	2·857	10 1/8	3 1/4
2 1/8	3·399	88·9	3·107	11 1/8	3 1/4
2 3/16	3·642	95·2	3·323	11 1/4	3
2	3·885	101·6	3·573	12	3
2 1/16	4·127	107·9	3·805	12 1/8	2 7/8
2 1/8	4·370	114·3	4·055	12 1/8	2 7/8
2 3/16	4·613	120·6	4·285	13 1/8	2 3/4
2	4·856	127·0	4·535	13 1/4	2 3/4
2 1/16	5·098	133·3	4·790	13 3/8	2 5/8
2 1/8	5·341	139·7	5·020	14 1/8	2 5/8
2 3/16	5·584	146·0	5·238	14 3/8	2 1/2
2	5·827	152·4	5·488	15	2 1/2

TABLE OF SCREWS—BY REULEAUX.

Diameter of Screw. d = mm.	Diameter at root of Thread d = mm.	Threads per mm.	Thickness of Head Millimeters.	WHITWORTH'S. Diam. of Screws. d = Eng. in.	Thr'ds per 1 in. Engl.	Thr'ds per length =diam.
6	4·1	7	7	¼	20	5
8	5·9	6	8	5/16	18	5 5/8
10	7·7	5½	10	⅜	16	6
12	9·5	5	11	7/16	12	6
15	12·2	4½	13	½	11	6 7/8
18	14·9	4	15	9/16	10	7 1/2
21	17·6	3¾	17	⅝	9	7 7/8
24	20·3	3	20	1	8	8
27	23	3	22	1 1/16	7	7 7/8
30	25·7	2½	24	1 1/8	7	8 3/4
34	29·3	2½	27	1 3/16	6	8 1/4
38	32·9	2½	29	1¼	6	9
42	36·5	2⅛	32	1 5/16	5	8 1/8
46	40·1	2¼	35	1⅜	5	8 3/4
50	43·1	1⅞	38	1 7/16	4 1/2	8 1/8
55	48·2	1⅞	41	2	4 1/2	9
60	52·7	1⅝	45	2 1/16	4	9
65	57·2	1⅝	48	2 1/8	4	10
70	61·7	1⅝	52	2 3/16	3 1/2	9 5/8
75	66·2	1⅝	55	3	3 1/2	10 1/2

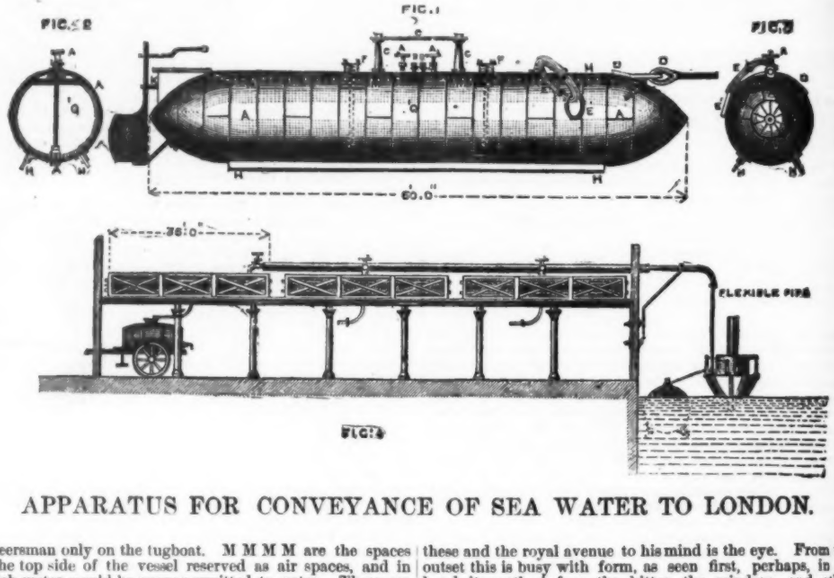
TABLE OF AMERICAN AND ENGLISH GAS PIPES.

Nominal Diameter.	U. S. STANDARD. Act'l outs. Diam. in Engl. in.	U. S. STANDARD. No. of Threads per inch.	ENGLISH STANDARD. Act'l outs. Diam. in Engl. in.	ENGLISH STANDARD. Act'l outs. Diam. in mm.	ENGLISH STANDARD. No. of Threads per inch.
⅛	0·405	27	0·406	10·318	19
¼	0·54	18	0·531	13·493	19
⅜	0·675	18	0·625	15·875	19
½	0·84	14	0·812	20·637	14
⅝	....	....	0·906	23·018	14
¾	1·05	14	1·031	26·194	14
⅞	....	....	1·187	30·162	11
1	1·315	11½	1·312	33·337	11
1¼	1·66	11½	1·625	41·274	11
1½	1·9	11½	1·875	47·624	11
1¾	....	....	2·125	53·974	11
2	2·375	11½	2·375	60·325	11
2¼	....	....	2·625	66·674	11
2½	2·875	8	3·0	76·199	11
2¾	....	....	3·125	79·374	11
3	3·5	8	3·5	88·898	11
3½	4·0	8	3·937	100·01	11
4	4·5	8	4·437	112·71	11
4½	5·0	8	....	....	..
5	5·563	8	....	....	..
6	6·625	8	.....	....	..
7	7·625	8	.....	....	..
8	8·625	8	.....	....	..
9	9·688	8	.....	....	..
10	10·75	8	.....	...	..

TORPEDO BOATS.—Two torpedo boats of the Batoum type, built for the Argentine Government by Messrs. YARROW & Co., have just been tested at the measured mile on the Thames, when their respective speeds in fighting trim were found to be 19·9 and 19·8 knots. These boats are of special design, and have been constructed under the superintendence of Captain Hunter Davidson. They are 100 ft. in length, and will shortly start across the Atlantic for South America.

CONVEYANCE OF SEA WATER TO LONDON.

MR. JOHN HAYES, of 27 Leadenhall street, London, proposes to convey water from the North Sea in a specially constructed floating tank, resembling the vessel which conveyed Cleopatra's Needle to this country. The features of this plan will be readily understood from the engraving. Figs. 1, 2, and 3 represent views of the sea water vessel, the dimensions of which are 60 ft. by 10 ft. diameter, and in which A A is the plating or shell of wrought iron ⅜ in. in thickness; A A are the inlet valves placed on the bottom of the vessel, and opened by a screw and wheel at the top of the same; B B are two air outlets which allow egress for air displaced by the sea water; C C are wrought iron columns supporting the guard rail, also marked *c;* D D is a strong iron framework for attaching the tow rope and hook to; E^1 is a life-buoy; F F are two valves secured or kept on their seats by spiral springs. A watertight bulkhead divides the vessel at the center; H H are two strong plate iron keels 18 in. by 1 in., secured by angle irons 5 in. by 5 in. by ⅜ in. to the shell, which latter, at the bottom or between the keels, is for the entire length of the vessel ½ in. thick; I is the rudder, and K the steersman's platform. It is expected, however, that this would seldom be required, if at all, as the double mode of towage would require a steersman only on the tugboat. M M M M are the spaces at the top side of the vessel reserved as air spaces, and in which water would be never permitted to enter. These are formed of ½ in. iron plates, supported and strongly attached to wrought iron frames, and stayed where necessary to resist a test pressure of 20 lb. to the square inch, applied externally by means of hydraulic power. This air chamber is divided longitudinally into two separate compartments, the intervening space being left for the valve spindles, A A, etc., to pass through. Fig. 4 shows the mode of handling the sea water on arrival at the wharf in the Thames, when the water would be pumped up into suitable tanks, and from which it would have ample fall for filling the water carts. On the ground floor, Mr. Hayes's design includes an additional feature in the form of a sea water swimming bath, measuring 100 ft. by 25 ft., and of a suitable depth. The sea water vessels, also the tanks for storage of the water, will be carefully lined with a special composition capable of withstanding the action of the sea water, and at the same time preventing it from getting discolored by contact with iron or any other material. It is proposed to send two of these tanks out to the North Sea, one lashed at each side of the steamer. E is a hose with a buoy at the end. Should one of the tanks be sunk air could be forced in through this hose, the upper end of which floats, and the vessel could thus be raised.—*The Engineer.*



APPARATUS FOR CONVEYANCE OF SEA WATER TO LONDON.

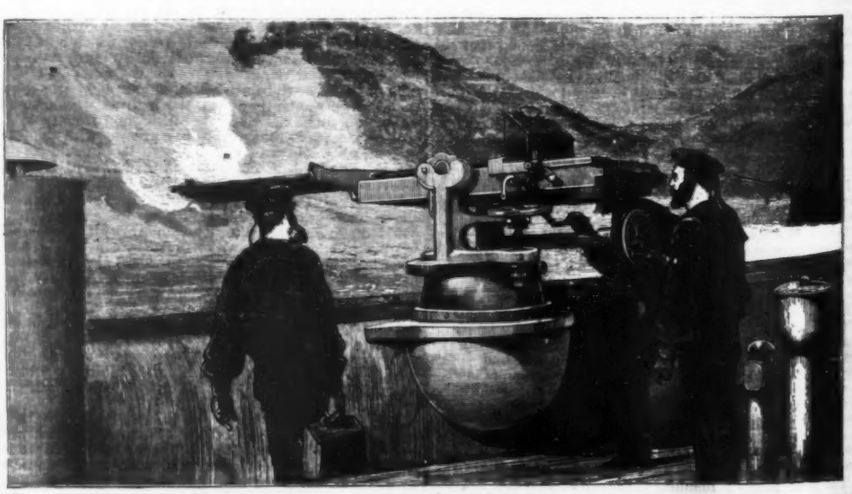
THE NORDENFELDT GUN.

THE Nordenfeldt gun is a species of machine gun or mitrailleuse, and has been adopted by the British Naval authorities for the main purpose of repelling torpedo boats, which, having been built to resist a volley of rifle bullets, are clad in steel armor. This, however, according to the recent experiments, is not sufficiently strong to resist the Nordenfeldt, which, with its four barrels, can fire twelve solid steel shot per minute. The barrels are consequently exceedingly stoutly made, being more than three inches in external diameter, where strength is most needed, providing a thickness of metal adapted for the employment of gun cotton cartridges. The gun is very rapid in action, it is traversed and elevated by simple appliances, and it has made most accurate shooting even at long ranges. Its stand, as may be seen in our engraving, is very heavily mounted on a bed of iron, the mechanism of the breech is worked by electricity, and altogether the gun has been pronounced a highly useful weapon for a ship's use, and in the days of hand-to-hand combats would have been invaluable in repelling boarders.—*London Graphic.*

THE QUINCY METHODS IN EDUCATION.

From an address of PROF. B. G. NORTHROP, LL.D.

A PROMINENT aim of Col. Parker in the primaries was to train the sense and form habits of careful observation of common things. He recognized the fact that the child's intellectual life begins with the reception of impressions from the senses, which are the windows of the soul. The noblest of these and the royal avenue to his mind is the eye. From the outset this is busy with form, as seen first, perhaps, in its hand, its mother's face, the kitten, the window, and other common objects in the nursery. The child recognizes hundreds of things by their *shapes* before he can count three. In the new education Nature becomes the great teacher. Facts, objects, common things are made the leading instruments of developing the faculties of the juvenile mind. Plato well said, "The Deity delights in geometrizing," for the world itself and everything in it is built after some geometric form or combination of these forms. Accordingly a large portion of the course of study printed during the last year to guide the teachers of Quincy is occupied with lessons in form. If youth should be trained to study nature, should we not give them the few exact forms which, singly or combined, are the patterns of all visible objects? As the child's mind naturally turns to form and size, if untaught in them his notions will be vague; but if trained in these elements of geometry, his perceptions are likely to be distinct and accurate. The majority of our pupils will never pursue geometry proper, but all should learn its forms. These ideas and terms will be especially useful to the carpenter, joiner, mason, worker in tin or any metal, or at any trade. Form enters into all our perceptions, descriptions, comparisons, imaginations, calculations, and, indeed, into all the arts, occupations of men—into the very texture of daily life. It has been said that those geometric elements are too difficult for the primaries. But the experience of many schools, at home and abroad, as well as at Quincy, shows that these elements are simpler than the first processes in arithmetic. Ideas of extension are more elementary and *attractive* than those of number. The relations of place, form, and size are among the earliest conceptions of the juvenile mind. The supposed difficulty of the subject is imaginary. The experience of thousands of



THE NORDENFELDT GUN ON BOARD H.M.S. MONARCH.

primary schools in Germany and in America shows that form is one of their earliest, easiest, pleasantest, and most useful occupations. With the gonigraph in hand as a sort of magic wand, the youngest children in all true kindergartens delight in making triangles, squares, rhombs, rhomboids, oblongs, pentagons, hexagons, circles, and other forms. Because they are made with facility and rapidity by their own little hands, these forms are understood and remembered.

In the primary schools of Quincy all are busy and all is life. Col. Parker visits them not as a mere spectator, for he habitually turns teacher. With crayon in hand he is a worker by turns in all the grades. His earnestness and enthusiasm give encouragement and stimulus alike to teacher and scholar, and it is inspiration that is everywhere needed, even more than mere instruction—or rather the great want is such instruction as shall awaken self-reliance and enthusiasm, and prompt the child every day to win some victory and go on from strength to strength. The child then feels that he is doing something, and this consciousness of achievement gives pleasant memories of the past and stimulus for the future. In visiting schools, it is often sickening to see what a dreary, monotonous, stupid task the exhilarating work of study becomes from the want of fit incentives and methods. You witness a sluggish, passive receptivity, or a mechanical movement fatal to all joyous activity. Happy the child whom a skilled teacher has inspired with such taste for study as will prompt and sustain spontaneous effort. Joy and hope ever attend true energy. They quicken the mind, as gloom and discouragement suppress its life. The one awakens interest and attention, the other produces heedlessness and indifference.

Col. Parker has wisely aimed to stimulate the *curiosity* of the children from the outset, realizing that curiosity is the parent of attention and memory. Curiosity prepares the soil and fertilizes the seeds of truth. A farmer might as well sow a field without plowing, as a teacher instruct pupils in whose minds no love of knowledge has been awakened. Curiosity, or what is kindred, love of knowledge, is one of the strong, natural desires which God has planted in the heart of every child. Though too often dormant, it may become one of the vital forces in education. However strong in childhood, it should grow with years and attainments. When this is not the result, such stinting comes from our blundering. Though at first a restless instinct, under fit culture it will mature into an insatiable desire, a ruling passion. Curiosity is to the mind what appetite is to the body. It creates a hungering and thirsting for knowledge which alone is the mind's food. Love of truth was as strong a passion with Newton as love of conquest with Napoleon. Under its healthful inspiration, study is a pleasure—without it a task, the dullest drudgery, "the weariness of the flesh." Curiosity is the primal desire to which the child's nature responds; it is the impelling power to which genius, when enriched with all the treasures of science, is most susceptible. What at first is but a blind impulse becomes an insatiable desire to observe and discover. The most bountiful supplies only add fuel to the flame. Instead of surfeit there comes an intense craving. Each new attainment gives strength and stimulus for higher acquisition.

The most serious charge of Mr. Adams against the old system was its failure to develop the power of expression. With his sentiments on this point I have long been in sympathy, and have often said that just here is the greatest deficiency of American schools as compared with the best schools of Switzerland, Germany, and England. With us, nothing of equal importance is so underrated and neglected as the culture of the expressive faculties. Until recently grammar was the only study in our curriculum professing to teach how "to speak and write the English language correctly." As ordinarily taught to children under twelve years of age, it has about as much adaptation to its professed design as the study of physiology and anatomy would have to swimming. Useful as grammar is, it is a difficult study, kindred to rhetoric and logic, and above the grasp of young children. In Quincy grammar was summarily put out of school, and daily exercises in talking and writing put in. The result is that the children write English earlier, write more, and write it better *throughout all the schools of the town* than is the case in all the schools of any other town within my knowledge in our country. Individual schools can here and there be found in this respect equal to any in Quincy. The pen or pencil continually in hand has made the Quincy scholars facile and felicitous in expression. They learn words by using them, phrases by making them, and sentences by writing them. Conversation is one of the attractions of the Quincy schools, as it is of the well regulated home. "What did you do last evening?" or "What did you see on your way to school this morning?" are specimens of many of the simple questions to invite habits of observation and then of "telling the teacher." Thus conversation is cultivated as an art. So should it be in every primary school. To teach how to talk well should be the constant aim of both home and school training.

One of the child's earliest needs is aid in utterance. The first aim should be acquisition of ideas by objects, and then their fit utterance by words. But repression, rather than expression, is often the result if not the aim in school. The talking is by the teacher when the pupil should first see and then describe. Every description thus made facilitates others and forms the habit of observation and description. Every fit description once given helps in the future command of language and fixes the facts described in memory. In the schools of Germany and Switzerland scholars write tenfold more than usually in America. The prominence there given to the study of the vernacular is largely due to the influence of Pere Girard, whose motto was, "The mother tongue the great educator." Well would it be for the youth of America if some Pere Girard would as effectually ring the changes on this cardinal maxim in this country.

An inspection of the schools of Quincy as they now are, contrasted with their former condition, convinces me that the recent progress has been striking in the following particulars:

1. There is a great increase of interest on the part of the pupils. They form a company of earnest and cheerful workers.

2. There has been a remarkable advance in the interest of parents and the people at large. The citizens of the town are now proud of their schools, and frequently visit them.

3. There has been an increase in the aggregate attendance as well as in its regularity and punctuality. No truant officers or truant schools are needed in Quincy.

4. There is far better reading and spelling. Great excellence is reached in these branches, especially in "sight reading," so-called.

5. The training in expression is remarkable. The scholars have learned to talk and to write well. They can tell what they know.

6. Habits of careful observation as well as exact description have been formed. To describe actions is often more difficult than to describe objects. To test one school in this matter, I went through a succession of steps—hops, jumps, with various gestures and gymnastics, and called upon the scholars each to write a narration of my pantomime. The result was a pleasant surprise to me in the fullness and accuracy of the description and the propriety of their language. They see quickly and can tell what they see.

7. There is a marked advance in the *morale* of the school. This is a point of supreme importance.

8. Their attainments in arithmetic are good, but in no wise remarkable, and in the matter of rapid mental combination, inferior to our best schools elsewhere.

9. In geography the use of the moulding board has made them familiar with reliefs, and for this purpose it is a happy device, but the contours of different countries and of the continents are more difficult to imprint upon the mind than the reliefs. On the moulding board but one or two work at a time, though all serve as critics. But on the motto so well carried out at Quincy in all other departments, that children learn best by doing, I doubt the wisdom of making the moulding board so prominent. Within narrow limits it is very useful, but as a didactic drill, and as an aid in training in observation, memory, and description, it is not comparable with the more general practice elsewhere of daily exercises in map drawing from memory. The reliefs are represented by colored crayons almost as vividly as by the moulder's earth, by which the elevations are often enormously exaggerated in their relative proportions. In all our best schools scholars study the maps and recite them by making them, and often making them every day and always from memory. That I may not seem partial to my own State, I will say that in my judgment geography is taught generally in the schools of New Jersey better than it is in Quincy. The memory maps of the Centennial Exposition surpassed those from any other State, and they included specimens from nearly every school of the State. I would ask any skeptics to visit the schools of New Jersey for confirmation of this view. On their journey thither I invite them to inspect the classes in geography in the Dwight School of New Haven.

Mr. Adams deserves great credit for the time and thought and heart he has devoted to the question of common school education, and especially to the radical defect of neglecting to train our youth in the use of our own language. The examinations of hundreds of schools and thousands of pupils by Mr. Walton fully confirm all he says on this point. Public attention has been called to this leading defect of our schools as never before, and great good will come from this discussion. Some obvious exaggerations in Mr. Adams' paper on other points are not unnatural, and certainly are pardonable in view of the great public service he has rendered to Quincy and to the cause of education throughout the country.

DONKEY CART

OUR engraving represents what is known by the makers as "Field's Epsom Car." We understand that it is in half-inch scale, but either the donkey must be undersized, or he has not had the full benefit of the scale named.—*The Hub.*

DONKEY CART.—(Scale, One-half Inch.)

OMNIBUS.

THIS omnibus is one of the latest designs made, and contains several good features. The application of coupé pillar to the omnibus is rather novel, the same as in its adoption on English coaches made recently. Its use on the omnibus and English coach is advisable and bears to be imitated.

Painting.—Body: lower panel below belt rail, dark Indian red; above belt rail, concave; panels and boot, black. Carriage part: same color as lower panel, striped with Indian red darkened a trifle, glazed with carmine. Bands black.

Trimming.—Outside seats, black enameled leather. Leather facings and welts. Japanned buttons, squab cushion tops. Inside seats, maroon enameled leather. Leather welts. Japanned buttons. Maroon carpet.

Mountings.—Silver.—*Carriage Monthly.*

OMNIBUS.—(Half-inch Scale.)

WIDE BOARDS, CUT BY MACHINERY, FOR COUPE TOPS.

CARRIAGE manufacturers are now using for tops to coupés, etc., wide boards, cut by machinery by the log being revolved against a knife cutting any width desired. These boards are dried thoroughly, and nailed on the curves, etc.

The entire under surface between the curves is then covered with small blocks, glued on with the grain running the opposite direction from that of the board. These tops are painted and finished in every way similar to the panels, and, so far as they have been tried, the tops are more durable than those made of narrow boards and covered with canvas and leather. —*H. & C. Journal.*

DESIGNS IN TEXTILE FABRICS.

THE extent to which really effective designing is already introduced in the textile manufactures of Philadelphia is inadequately understood by the general public, and particularly in the countries from which all artistic designing is supposed to originate. In fact, it is here the most uniform and general practice to originate designs in carpets and upholstery coverings particularly, and only in dress goods are the patterns habitually taken from imported samples. There are ten or twelve independent establishments, employing several persons each, engaged in the preparation of original patterns in carpets and upholstery coverings, on the orders of the mills producing these goods. The patterns are first painted on suitable paper or cloth, prepared for adjustment to the number of threads of each color, and the Jacquard boards are then cut by proper machinery, the workman having the pattern before him. The pattern is then ready for the weaver by simply putting the Jacquard cards in his loom. Nothing of this is new, except that it is not understood as it should be that the hand-loom weaver of ingrains or stair carpets habitually uses all these patterns, and produces a degree of elegance in design and finish for the most ordinary carpet which certainly can not be excelled by any country.

Very few of the carpet looms in use now are without the Jacquard attachment, and the real elegance of their work should be seen and studied by those who doubt the superiority of American carpets. It is this that gives them the control of every market they have ever reached, and has

carried the aggregate of their production to really enormous figures.

Next, the Turkish, Smyrna, or Persian rugs, only recently introduced, represent a high degree of skill in designs and finish. Some of the leading carpet manufacturers, as the Bromleys, have gone very largely into these popular goods, making every grade, from the heaviest double-faced single piece carpets, three to five yards square, to the lightest Chenille foot-rugs, and at prices with which no competition is possible in importation. The same freshness and facility in designs are shown in these, and in their associates, the Axminster carpets. The only error likely to be committed is the reduction in weight which the easily cheapened American market demands when any fabric becomes universally popular.

In upholstery coverings still greater refinement in designs and patterns has been introduced, and the manufacture of these goods now goes on in immense quantities. Broad iron looms, taking one and a half yards or more in width of fabric, are employed, with the most complicated Jacquard attachments, weaving exact reproductions of imported designs or new creations of the many skillful designers employed. The goods themselves are equal to the finest and most elaborate of the French, and as to material range from all wool and silk to all cotton, as the trade demands. The consumption of these goods has been very great for two or three years past, and not one-twentieth part of the supply has been imported.

It is only just to the rich and elaborate developments of taste, enterprise, and skill on the part of our own manufacturers, who employ the highest skill without stint, and fill the markets with the richest and most tasteful productions, to let these facts be known. There is no harm in getting everything new that can be got, and in educating the public taste up to the highest standard; but if there is taste to be studied or elegance of designs to be reproduced or created, the public may be sure that the American manufacturers of textile fabrics do not sleep over the opportunity, and that they can and do show in the open market fabrics superior in general taste and elegance to those of any market of Europe.—*Textile Record.*

OCEAN CABLES.

THE chief matters of interest in Atlantic cable affairs during the past year have been the "cable war," and the great increase in business.

The Compagnie Français du Télégraphe de Paris à New York, better known as "the New French cable," although completed in November, 1879, was only opened for business January 20, 1880, simultaneously with the opening of the American Union Telegraph Company. It commenced business by charging seventy-five cents per word, the same rate as the old companies. The "war" soon spread, and on the 1st of February the Anglo-American Company reduced its rates to France, and subsequently to Great Britain and Ireland, from 75 to 12½ cents per word. In a few weeks the new French Cable reduced its rates to 50 cents per word; the Direct Company followed suit with a 50 cent rate, while the Anglo-American still maintained the 12½ cent rate. By June the Direct Company came down to 37½ cents per word, leaving the New French Company alone with the 50 cent rate. Cable business then became enormous, the Western Union Company having a quadruplex and duplex at work night and day to North Sydney, and a quadruplex to Duxbury, "feeding" the ocean lines. So the situation remained until October 1, when, by mutual consent, the rate on messages to Great Britain was fixed at 50 cents per word, it being understood that the 12½ cent rate to France should continue until December 1.

The year 1880 has seen a great increase in ocean cables all over the world, nearly all of which have been duplexed. The Anglo-American Company has laid a new cable from Valentia to Heart's Content. This cable was laid in the remarkably brief period of eleven days—between August 10 and 21—and is known as "the 1880 cable," although it includes the shore end of the abandoned 1866 cable. During last fall the Anglo-American also laid a new three-conductor cable between Placentia Bay, N. F., and Lloyd's Cove, C. B.

Cables have also joined up the most remote parts of the world during the past year. Block Island has been connected with the Massachusetts coast. A cable laid in November last, from the Island of Grand Menan, in the Bay of Fundy, has afforded the inhabitants of that region their first telegraphic communication with the outside world. Cables have been laid during the year across Cook's Straits, New Zealand; from Manila to Hong Kong; along a great part of the western coast of South America; and cables now connect all parts of Australia and New Zealand with Java, Singapore, Malacca, Penang, and, of course, the rest of the world. Several cables have also been laid in the Baltic Sea.

Several new Atlantic cables have been projected—two, at least, of which will be laid and controlled by American capitalists. Hitherto Atlantic cables have been exclusively Old World affairs. They will probably be laid from Penzance, England, to Whitehead, Nova Scotia, touching at Sable Island. Another one—the "European, American, and Canadian Cable"—has been planned in Canada. A cable from the European continent to Iceland has also been talked off; the Mexican Government has approved a contract for a cable across the Gulf of Mexico, connecting Mexico with the United States; and it is hoped that, during this month, Mr. Cyrus W. Field (who eats his New Year's dinner to-day in Hong Kong) will materially advance the prospects of a Pacific cable from California to China, via the Hawaiian Islands.

Mishaps to the cables have been remarkably few during the past year, although the Anglo-American is reported to have suffered twice. Its 1873 cable broke off the Irish coast in April, but was speedily repaired, competition then being at its height. In November last its Brest cable was reported broken 230 miles from Brest. Stormy weather prevents its repair at present. In view of the Anglo-American having recently raised its tariff, and the French government objecting to the rise on this particular cable (a right obtained by virtue of certain landing concessions), the "break" was, to say the least, an agreeable one for the company, since it has two other cables on which to do business at the higher tariff. The New French cable was broken during the month of May, between St. Pierre and Brest.

The Chilians, in prosecuting their unrelenting warfare against Peru and Bolivia, have introduced some knotty questions for international lawyers to wrangle over, by resorting to the uncivilized expedient of cutting international telegraph cables. They have cut the submarine cables laid by the West Coast of America Telegraph Company, and the subject has been already brought to the notice of the British Parliament. This may, however, result in the adoption of the suggestions of Sir Travers Twiss, regarding an international treaty protecting telegraph cables in time of war.

The proposed scheme for a cable from New York to Holland, France, and Portugal, via the Azores and Land's End, in England, does not seem to be flourishing.—The deposit of $100,000 required by the Portuguese government was not made at Lisbon within the required period, but the time was extended until December.—*The Operator.*

DESILVERIZATION OF LEAD.

AT a recent meeting of the Philosophical Society of Glasgow, Mr. J. E. Stoddart read a paper on the "Desilverization of Lead by the Zinc Process," as carried on at the Clyde Lead Works, Glasgow. He said:

The treatment of argentiferous leads with zinc for the purpose of extracting the silver and refining the lead is by no means a novel process. About twenty years ago a metallurgist named Parks took out patents for desilverizing rich leads by means of zinc, and a manufacturing firm adopted his process. They were, however, subsequently obliged to abandon it, in consequence of the difficulty experienced in the separation of the zinc from the concentrated silver, to admit of the cupellation of the latter metal. A German chemist named Flach afterward took up the subject, and, by running the alloy of zinc, silver, and lead, along with iron slag, through a peculiarly constructed blast furnace, was enabled to free the concentrated silver-lead from zinc. He also proposed the use of this furnace for removing of traces of zinc from the desilverized lead, but this was abandoned in favor of the ordinary improving or calcining pan. The operation with the blast furnace was found to be very troublesome, and, as the greater portion of the zinc was entirely lost, was by no means economical.

M. Manes, of Messrs. Guillem & Co., Marseilles, who were the first to work Flach's process, found out and patented a simple means of treating the alloy and recovering the zinc by distillation. This is the process now in use and known as the Flach-Guillem process, and which is carried on in the following manner: About eighteen tons of "rich lead," containing generally from sixty to seventy ounces of silver per ton, are melted in a large cast-iron pot, to which one per cent. by weight of zinc is added, and the whole well stirred for twenty minutes. The fires are drawn, and the contents allowed to settle and cool until the zinc rises to the surface, and forms a solid ring or crust containing the silver and other foreign metals. This alloy is removed to a small pot at hand, where part of the lead is sweated out and the alloy thoroughly dried. The large pot with the lead now partially desilverized is again heated up, and treated in the same way as before, but with the addition of only a half per cent. of zinc, which, when it has risen to the top, is removed, as before, and dried. A third addition of a quarter of per cent. of zinc is found necessary to take out the remainder of the silver, care being taken, on the cooling of this zincking, that all the crystals are cleanly skimmed off.

The lead in the large pot is assayed, and found almost always to contain less than 5 dwts. of silver to the ton of lead; if it should happen to contain more, it is due to carelessness on the part of the workmen. The pot is now tapped and the lead run down into an improving pan, where it is kept to a high heat for nearly eight hours, for the purpose of oxidizing or burning off the small percentage of zinc which is left in it from the zincking process; after seven or eight hours' firing in this pan it should contain no trace of zinc. It is then tapped and run into moulds for market lead, or for the manufacture of lead products.

The old improving pans were made of cast iron, placed on a bed of sand, with a groove in the upper sides, which groove was filled with bone-ash to prevent the action of oxide of lead on the iron. These pans, from the giving way of the bone-ash, and the great wear and tear on the iron from the high heats necessary, were found to be both troublesome and expensive; they were very often under repair, and seldom lasted more than six or eight months. They have been superseded by an improving pan of cast iron lined with brick inside. This pan, instead of being placed on a bed of sand, as was the case with the old improving pan, is hung on brick walls, and is quite open both below and round the outside. This new pan has been working in the patentee's works, Marseilles, for some years, without any break-down. It burns no more coal, and can be as economically worked in every way as the old pans.

The zinc and silver alloy, after being dried, is melted in a plumbago crucible, covered on the top, well luted with fire-clay, connected with a small cast-iron receiver by means of a plumbago pipe, and fired up with coke. The zinc distills over, and is condensed in the iron receiver. After all the zinc has been distilled the pipe is disconnected, the cover removed, and the lead and silver left in the crucible is ladled out into the moulds. Thence it is taken to the refinery, where it is cupelled in the usual way. The block of metal zinc recovered in the condenser is removed, and used over again in the first part of the process. All the oxide of lead and dross formed in the different processes are taken to the reducing furnace, mixed with coal dross, and reduced back to the metallic state.

The refuse from this furnace still contains some lead, and is put through the slag hearth, a blast furnace fired with coke, the fumes of lead oxide from which are condensed in what is known as Johnson's patent condenser, and are all recovered. The lead from the slag hearth, containing a number of impurities, as copper, antimony, iron, or sulphur, is taken to the improving furnace—a furnace built in exactly the same way as the dezinckifying pan.

About twenty tons of this lead are heated for a period generally from four to five days, but the time varies according to the amount of impurities present. The oxidized impurities, as they are formed, float to the surface, and are skimmed off by the workman, who is made to keep the lead perfectly clean, so as to have a fresh surface always exposed to the action of the flame. The dross skimmed off is at first of a black color, but gradually becomes lighter as the operation goes on, until it shows nothing but yellow oxide of lead. When this appearance is noted the pan is tapped into moulds, or into the desilverizing pot, where it is treated with zinc, and the silver extracted as in the manner before described. By this process the lead can be desilverized and turned out in the shape of market lead in thirty hours from the time it is put in process, the loss in working being not more than one and a quarter per cent., and the amount of oxide of lead formed is very much less than that formed in any of the other processes, thereby effecting a very considerable saving in the working expenses. It makes an excellent quality of sheets, pipes, red lead, and litharge, and has even been used for the manufacture of white lead. There is, however, one product it cannot be used for by itself, and that is the manufacture of chemical lead.

Your president gave us a very interesting paper on this subject last session, showing that the reason of its not being suitable for this was on account of its extreme purity. I understand that Mr. James Napier, Jr., of this society, has done a number of experiments in the same direction, and found that, by adding to it a small percentage of copper or antimony, or both, a good chemical lead can be obtained. That all the silver is thoroughly taken out may be seen from the fact that there is an excess of silver obtained on the large scale to the extent of nearly two per cent. over the assays. An analysis of the market lead gave: Antimony, 0·0015, and silver, 0·0004 per cent., a trace of copper, but no iron or zinc; from which it will be seen that the lead refined by the zinc process is almost chemically pure, and to this is due the finer quality of the products manufactured from it.—*Chemical News.*

THE MANUFACTURE OF SULPHATE OF AMMONIA.

AT the recent meeting of the Midland Association of Gas Managers, Mr. G. E. Stevenson (Peterborough) read a paper as follows:

The residual products resulting from the manufacture of coal gas have, during the past ten years, received a much greater share of attention on the part of gas companies and of corporations having the gas supply in their hands than was formerly the case. One of the reasons for this is the increased value of the tar and the ammoniacal liquor; the tar on account of the development of the demand for tar products consequent on the discovery of the aniline dyes, and the liquor for the salts of ammonia into which it is now universally manufactured. At first those companies who had made long contracts for the sale of these residuals were well content to find, on the expiration of the contracts, that the value of the tar and of the liquor had increased enormously, tenders being in some cases made at a price more than double that of the former contract. In regard to tar, there are at present few gas makers who care to take upon themselves the risks and responsibilities attendant upon the distillation and the preparation of benzole and anthracene; while the further manipulation of these substances into the dyes of commerce is, I believe, in the hands of a comparatively small number of manufacturing chemists, who keep the practical part of the process as much as possible a secret from the world at large.

After a rapid rise, there has, during the past two years, been a diminution in the value of tar products, the supply appearing to have somewhat exceeded the demand, and the manufacture of these products has not of late yielded much profit. I am not aware that any gas company, with the exception of the Gaslight and Coke Company, has been found sufficiently venturous, during the last few years, to commence the working up of their tar themselves, the general impression being that an equally good profit may be made by the sale of the raw tar as by attempting to distill it on a small scale. The case is different in regard to the ammoniacal liquor. The working up of the liquor *in situ*, instead of selling it to private manufacturers, appears to advance hand in hand with improvements in scrubbing appliances, both springing from the desire to realize the utmost value from the source or profit which the ammonia existing in coal gas presents.

Whether the demand for ammoniacal salts will continue firm, in the face of a great increase in production, is a question which cannot easily be decided. Although the price of sulphate of ammonia is partly regulated by that of nitrate of soda, the former appears to be gaining in favor as possessing its nitrogen in a better form for the treatment of the soil, and it seems probable that for this reason, and also because of the more extended use of artificial manures of all kinds, we shall not for many years see the production exceed the requirements of the market in regard to this article of commerce. However this may be, at the present time the ammoniacal liquor is a valuable residual of gas manufacture, and it has become a matter of considerable importance that its full value should be realized by the undertakings themselves, and that the profit derivable from it should not be allowed to pass into the hands of an intermediate class of manufacturers, especially as the production of sulphate of ammonia is no complicated process requiring special scientific knowledge or skill on the part of the manufacturer, nor necessarily attended by any risk or danger.

Although a price can sometimes be obtained for the liquor which will realize as much profit as if the liquor were worked up into salt, in most cases this is not so. The ammoniacal liquor, being bulky, its carriage is costly, whereas the manufactured salt, bearing a high value in comparison with its weight, can be delivered within any reasonable distance at a moderate expense. The position of the works in regard to the purchase of the acid required in the manufacture is a matter of importance, as this chiefly decides the question whether the manufacture of sulphate of ammonia may be profitably carried on or not. The apparatus to be used is a point worth careful study, and it is this that I desire chiefly to consider in my paper to day.

It seems to have been at one time a prevailing opinion that any rough-and-ready method of procedure would do for this department of manufacturing chemistry. The great desideratum, it was supposed, was to have an apparatus as simple and as cheap as possible. Being a by-product in a gas works, upon which, at first, comparatively little depended, anything would do so long as the liquor was somehow or other worked up, and the salt got rid of. An old boiler was purchased and fixed along with a saturator of the roughest description. The liquor was put into the boiler, a certain quantity of lime added, and the whole boiled up till the ammonia had distilled over, when the fire was drawn, the boiler emptied, and the process commenced afresh. The saturator was a box with a movable lid, and after the acid had been put in, the lid was adjusted, the fume-pipe connected to some chimney flue, and when the charge was neutralized the lid was removed and the salt got out. Fresh acid was from time to time added to the mother liquor as required, and it would often happen that the charge was saturated before the ammonia was worked off, in which case it was necessary to remove the lid, and introduce an additional supply of acid while the brewing was proceeding, at the imminent danger of suffocation from the ammonia and other vapors arising from the open saturator. The evils of this method of procedure could, of course, only be tolerated when the manufacture was in a very small way indeed. Various improvements were introduced, modifying these defects. A diaphragm was introduced into the saturator, cutting off that portion of it receiving the ammonia, and what is called the pocket saturator was formed. Other saturators had their lids fastened down, and a sliding shutter in the top or side to insert the acid and withdraw the salt. A second boiler has been in

some cases introduced, and the liquor distilled by means of a perforated steam-pipe instead of by direct firing. In this form numerous appliances are existent at the present time, doing efficient work.

This system of manufacture, however, entails two evils which cannot be got rid of, except by an entire change of procedure. First, the process is intermittent. The charge of liquor in the boiler must be worked off, run out, and a fresh supply put in before the distillation can be continued. Even if the boiler were fed with a constant supply of liquor, the stream of ammoniacal gas must be stopped while the saturator is emptied and charged afresh. All this implies loss of time, and the consequence is the apparatus must be designed of larger capacity for a given production of salt than would be necessary if the process were continuous.

The second evil is of more serious consequence. The ammoniacal salt being deposited in the saturator, the latter must of necessity be opened for the purpose of getting out the salt. In this lies a source of danger which has produced in gas works alone, during the past two years, two disasters fatal to the lives of workmen employed. The danger arising from the possibility of opening the saturator during the distillation may be reduced to a minimum in the case of extensive plant where constant supervision is exercised. At Beckton, for instance, where the saturators are placed under a large shed open at both ends and well ventilated, the pocket saturators there used may perhaps blow with impunity, but in small works, where men cannot be always watched, and where the space is confined, such an arrangement is often a fruitful cause of accident

In order to obviate the necessity of interrupting the production of ammonia from the gas liquor, the method has been resorted to of passing the ammoniacal liquor through a column filled with coke, or other material calculated to divide up the liquor into fine streams, and subjecting it to the influence of steam introduced at the bottom of the column, by which means the ammonia is distilled out of the liquor as it passes through the column. The Coffey still also presents a ready and suitable contrivance for this purpose; the liquor flows backward and forward over a series of trays from the top to the bottom, and the steam passes upward over the surface of the liquor. I am unable to state when either of these appliances was first made use of for distilling ammonia. The coke column is, I believe, favored by many private manufacturers. It occupies a considerable space, and cannot, on account of its height, be conveniently placed under cover; otherwise it gives, I believe, satisfactory results.

The Coffey still is used of various forms and dimensions, and there appears to be a considerable difference in its efficiency according to the design. Some stills never take out all the ammonia from the liquor, and are consequently to be classed as defective examples of this appliance. The liquor must traverse a sufficient length of tray surface, must flow over the trays in a sufficiently thin stream, and must occupy a certain length of time in traveling from the top to the bottom of the still, otherwise the distillation will be imperfectly performed. If these considerations be fulfilled, I know of no better system of distilling ammoniacal liquor. To obviate the possibility of danger arising from opening the saturator, it is only necessary to have recourse to the evaporative process. If the acid be used in a concentrated condition, the salt will be deposited in the saturator, and must be removed in a solid form; but if the acid be diluted, the salt will remain in solution after the charge is neutralized, and will require evaporating to a sufficient degree of concentration before the salt will crystallize. If this plan be adopted, the saturator may be altogether closed, the acid being run in by a siphon-pipe from a tank, and the neutralized charge run off by an outlet-pipe at the bottom. When steps were taken three years ago to erect a sulphate of ammonia factory at the Peterborough Gas Works, I decided upon adopting this plan, as presenting the maximum of safety and certainty in working, and as my experience of the working of the apparatus has been eminently satisfactory, I have thought that a description of it might be not without interest to some members of this association.

The engraving (Fig. 1) represents part of the building and the apparatus in plan, Fig. 2 being the section. The factory proper is 26 feet square and 20 feet high to the springing of the rafters. The roof is constructed with a central square ventilator having louvers on all four sides. This and openings in the walls above head afford ample ventilation, which is further secured by air gratings round the floor line. Alongside the factory is a sulphate store, and the building also comprises a chemical laboratory conveniently situated for experiments connected with sulphate manufacture. The liquor is pumped from the tanks in the yard, by a Tangye's "special" steam pump, into a wrought-iron tank fixed on brackets against the wall of the building, at a sufficient height to admit of running the liquor into the still by gravitation. The still is represented in section in Fig. 3 annexed. It is rectangular in form, and measures 4 ft. 6 in. by 3 ft. by 9 ft. long, and is constructed of half-inch cast-iron plates firmly bolted together with half-inch bolts. The trays are made of wrought iron, No. 12 B. W. G. in thickness, and they are turned up at the edge five-eighths inch. They are separated by wood packing pieces bolted to the sides of the still. The spaces between the trays are only $3\frac{1}{2}$ inches in depth, much less than is usual in the Coffey still, and herein lies greatly the secret of successful working. If the spaces were greater the steam would pass away without coming into intimate contact with the liquor. Additional height of still will not compensate for this, because the steam would lose its pressure in occupying the enlarged spaces, and the rush will be wanting which attacks and agitates the surface of the liquor. Although the still is only 9 feet high, the length of tray surface over which the liquor has to travel is 100 feet, and the liquor occupies ten minutes in passing from the top to the bottom of the still.

The steam enters at the bottom of the still, and along with the steam also the ammonia from the lime boiler, to

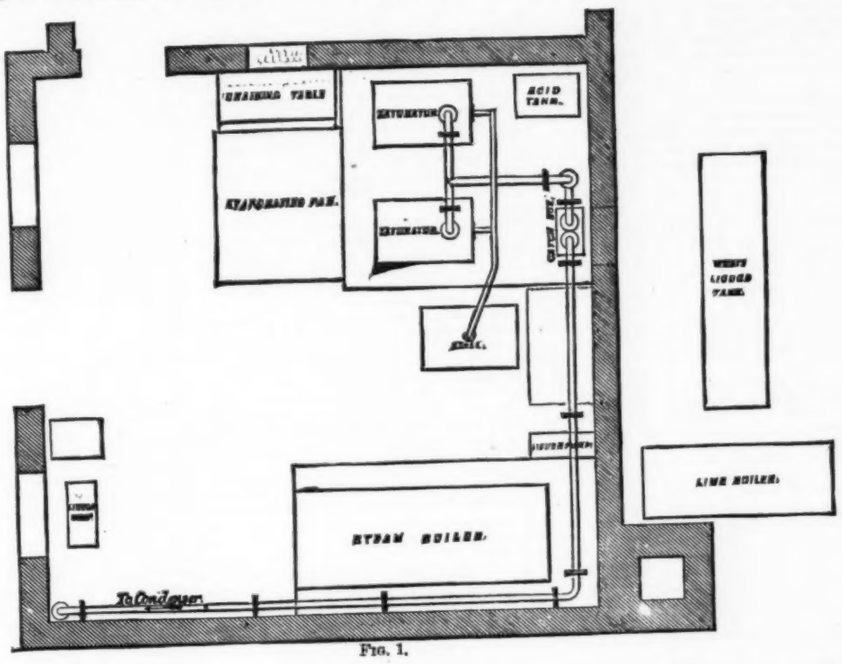


FIG. 1.

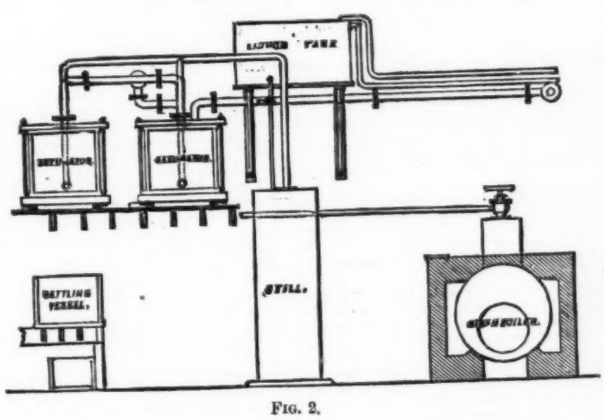


FIG. 2.

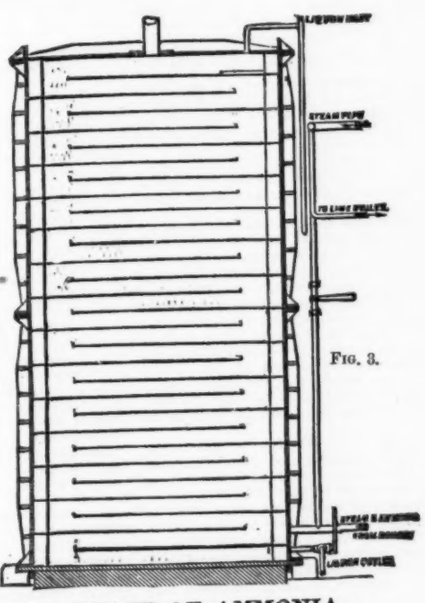


FIG. 3.

APPARATUS FOR THE MANUFACTURE OF SULPHATE OF AMMONIA.

which reference will be presently made. The ammonia and steam pass out by a three-inch pipe from the top of the still to the saturators, of which there are two. These are rectangular boxes 5 ft. long by 3 ft. wide and 2 ft. 9 in. deep. The lids of the saturators are bolted down by six long tie-bolts passing through wood crossbars at top and bottom. They are lined with lead from 6 to 12 lb. weight per square foot. The acid, diluted in the proportion of two parts of water to one part of acid, is supplied from a tank at a convenient level for gravitating into the saturators. The charge for one saturator consists of two carboys, or about 3 cwt. of acid. The neutralized charges are drawn off from the saturators into a settling tank, and from thence, after the impurities have been allowed to settle, are run into the evaporating pan. This is a flat wood tank, 6 ft. by 7 ft. in area, lined with lead and containing a coil pipe (1 inch diameter) through which steam is passed to boil up the liquor. The coil is arranged round the sides of the pan, and the salt falls into a clear space in the center. It is afterward shoveled out on to an inclined draining table, and when dried thrown through a trap-door in the wall into the adjoining store.

As the prevention of nuisance from foul smells is an

important thing where the works are situated in the neighborhood of dwelling-houses, special means were taken to prevent the escape of any sulphurous fumes or ammoniacal vapor. The outlet-pipe conducting the waste gases from the saturators is carried round the building to a condenser situated outside, where any traces of ammonia are condensed along with the aqueous vapor, and the sulphureted hydrogen is conveyed away by an underground pipe to the retort house, where it is burnt in the main flue of the retort settings, and passes out of the chimney as sulphurous acid.

It was found during the first year of working that the whole of the ammonia escaping from the saturator at the end of the charge was not recovered in the condenser. To remedy this a catch-box was inserted in the fume-pipe. This small box, 2 ft. long by 1 ft. 3 in. wide, is filled with dilute sulphuric acid, and the pipe from the saturator dips into the acid, and is perforated in the same manner as the saturator inlet-pipe, so that the waste gases must bubble through the acid before escaping. This effectually prevents any ammonia from being lost. The box is emptied into the settler when acid is neutralized, and fresh acid introduced by a funnel at the top. In starting the apparatus, the still is first heated by passing steam through it, after which the charge is run into the saturator, and the liquor turned on. The waste liquor issues by a cock at the bottom, and is run into a tank at the back of the factory. The steam and liquor supply must be regulated so as to get the maximum quantity of liquor without allowing any ammonia to escape at the bottom of the still.

When the apparatus was first designed no provision was made for taking out the fixed ammonia from the waste liquor. During the past summer an arrangement was made for this purpose, as follows: A plain cylindrical boiler was fixed at the back of the factory, and the waste liquor pumped into it alternately with milk of lime. Instead of passing the steam from the steam-boiler direct into the still, as formerly, it is first sent through a coil in the lime boiler to agitate the liquor, and from thence passes into the still, carrying with it the ammonia driven off from the waste liquor. This arrangement works satisfactorily, except that traces of ammonia are washed back by the liquor descending through the still, which causes part of the work to be done over again. To obviate this, I intend to have the steam and ammonia from the lime boiler introduced higher up in the still, and use an accessory steam supply at the bottom of the still to liberate any remaining ammonia which may be washed down.

With regard to the productive capacity of the apparatus, it is found that with liquor of 9-ounce strength the apparatus can easily make 3 tons of salt per week. Only one man is employed, who receives occasional assistance from a laborer. Without working overtime, the man in charge can work off five carboys a day on an average, the liquor being delivered through the still at a rate of about 150 gallons per hour. A charge occupies four hours in working off, so that 2½ charges fall within one day's work. The evaporation of charges previously saturated goes on simultaneously with the distillation of the ammonia in the still. The factory is not worked at night, though this could, of course, be done if required. At present ten hours work per diem is more than sufficient for working up the whole of the liquor made, together with what can be purchased from small gas-works in the neighborhood. After stopping work at the close of the day the boiler fire is banked up, and the steam-cock to the still left slightly open to keep the still warm. In the morning a very short time suffices to get up steam again and recommence work.—*Journal of Gas Lighting.*

HISTORICAL NOTES ON GAS ILLUMINATION.

AT the present moment, when the public is all impatience to see the electric light perfect for general illuminating purposes, it may be interesting to note a few particulars descriptive of the early days of gas, when it struggled into existence for the same purposes.

In looking over a few somewhat ancient scientific papers I found much relating to the subject, and will now reproduce these historical facts in the order in which I found them.

It appears that in the British Museum there is preserved a paper (Ascough's Cat. 4437), entitled "Experiments Concerning the Spirit of Coals, in a Letter to the Hon. Mr. Boyle, by the late Rev. James Clayton, D.D., B. Mus." These experiments were undertaken by him in consequence of his having observed that the gas, issuing from certain fissures near a coal pit at Wigan, in Lancashire, took fire when a burning candle was presented to it. He therefore distilled coal, and obtained first "phlegm," afterwards a black oil, and then "an inflammable spirit," which he collected in bladders. By pricking these bladders he was able to ignite the gas at pleasure. Hence it is evident that the discovery of the carbureted hydrogen gas took place previous to the year 1664.

So states a paper, No. 66, in the *Philosophical Journal*, by Mr. John Webster, "On the Discovery of the Inflammable Gas from Coals;" the date of the paper is not before me, but its republication, in the form I found it, was in 1807.

In the *Phil. Jour.*, No. 67, the subject is again mooted by a Mr. Hume, who states that in the forty-first volume of the Philosophical Transactions, p. 59, is a "sheet paper," which appears to have been read before the Royal Society in January, 1739, as "A Letter to the Hon. Robert Boyle, from the late Rev. John Clayton, D.D., in which is described how the discovery originated, and also some of the effects produced by this gas or 'spirit' of coal."

Mr. Hume further draws attention to the difference in the Christian names given to Mr. Clayton, in the first instance "James" and the second "John," and draws the very probable conclusion that the same person is referred to in both papers, and states: "At any rate, the merit of this discovery can be no longer claimed by any living person."

This remark was called forth on account of the public papers of that day, 1808, being much taken up with the proposal of a Mr. Winsor to light cities with gas. It appears that Mr. Edward Heard also obtained a patent in June, 1806, for "Obtaining inflammable gas from pit coal, in such a state that it may be burned without producing any offensive smell."

There was money in this patent, for Mr. Winsor was organizing a large company which was not to buy the patent, but to pay a royalty as a license for the exclusive right to make use of it. As usual in such cases there was a great outcery, and the attempt was made to break down the patent by asserting that the invention was not new, one Nicholson taking the ground that the patent was invalid, because the inflammable nature of coal gas was demonstrated by "Boyle" before 1691; and he further stated that Lord Dundonald used gas from coal to give light many years ago, and that a Mr. Murdock also put it in practice upon a large scale in 1792 and 1798, so that it was absurd for Mr. Winsor to claim the invention for the public use of gas.

To parry these attacks Mr. Winsor published a small pamphlet, and boldly asserted that it was true that the inflammability of coal gas had been long known, but that no one *had purified gas*, and thus made it fit for general illuminating purposes, until he took out his patent in 1804. He also accused others, who were in the field, of having obtained their knowledge from him.

Mr. Winsor had to contend against other difficulties; for, at that date, the statute law of the realm prohibited more than five persons holding a patent as joint property, and it was held that as the shareholders of the proposed company would share the profits, they would be joint holders of the patent. To this Mr. Winsor replied that he retained the patent himself and merely sold the right to use it. To show the poor prospects for gas illumination entertained in those days, the remark of the editor who published these papers is significant, for he says he "regards the whole scheme as a bubble."

The next paper before me, "On the Application of the Gas from Coal to Economical Purposes," by Mr. William Murdock—*Phil. Trans.*, 1808—shows the question to have advanced to the stage when a large building had been illuminated by gas; this building was the cotton manufactory of Phillips & Lee, of Manchester, England, the whole of which, together with the dwelling-house of Mr. Lee, was lighted with gas.

This was thought, at the time, to be a great feat, and shows by what slow degrees the process of gas illumination was developed; the idea of a central manufactory of gas, and that of carrying it by pipes throughout a district, never entered the minds of the most advanced advocates of the system, but that each house or establishment should manufacture its own gas and use it, was considered the perfection of gas lighting.

Mr. Lee distilled the coal in large iron retorts, and the gas was conveyed into large gasometers, where it was washed and purified, and then conveyed to the burners. There were 271 burners on the principle of the Argand lamp, each of which gave a light, as measured by means of shadows, equal to four mould-candles of six to the pound, and 633 burners, called cockspurs, having three apertures only of one-thirtieth of an inch, and of which the light was equal to two and a quarter of the same candles; so that the whole of the lights were equal to 2,500 candles of that size, each of which consumed four-tenths of an ounce, or 175 grains of tallow in an hour. Mr. Murdock continues: "The quantity of gas required by this number of burners was 1,250 cubic feet in an hour. In some mills where the work is light, the average time required will be three hours, but in this manufactory the yearly average is two hours a day, or 2,500 cubic feet of gas. This quantity of gas required the distillation of 7 cwt. of cannel coal." The expense of the lights used in this manufactory may, therefore, be stated thus:

Cost of 110 tons of best Wigan cannel, at 22s. 6*d.* is.....		£123
Cost of 40 tons of common coals to heat the retort at 10s. is.....		20
		£143
Interest on capital and wear and tear of apparatus.		550
Attendance, the same as when candles are used, therefore need not be stated		0
		£693
Deduct value of 70 tons of coke.....	£98	
Value of 1,250 ale gallons of tar not yet sold,	0	£98
		£600

"The expense of candles to give the same light would be, at 1s. per lb., nearly £2,000. The light is peculiarly soft and clear, and of almost unvarying intensity, so as to be very pleasant to the workmen. It is also free from the danger of spark."

This will give an idea of the method of making comparative calculations then used to determine the merits of gas as against the use of candles. The editorial remarks on this paper might, if the word gas be substituted for electricity, be taken for one of the criticisms so lately in fashion, and now a little obsolete.

"The present paper furnishes the necessary data for calculating the quantity of coals that would be required to yield a light equal to that of a given number of candles; and it affords an easy means of investigating the economical advantages of this process, which seems well adapted to the illumination of public buildings, large manufactories, and generally speaking, all establishments where a great number of lights are required; but we fear the *expense of the apparatus will always be against its introduction in domestic establishments* on a small, or even middling scale."

The last paper I notice is "*On the Advantage* of Employing Coal-gas for Lighting Small Manufactories, and for Other Purposes," by Mr. B. Cook, *Philosophical Journal*, No. 94.

Mr. Cook in this paper drew attention to the increased price of tallow, on account of the "rupture with Russia," so that the advantage of using coal-gas becomes evident. It is true, he says, that coal itself might increase in value, but, as he suggests, it might lead to an increased search and greater production.

Mr. Murdock explains the method of making gas for large manufactories, and Mr. Cook in his paper describes his plan for making gas for dwelling houses. "Such an apparatus," he says, "should be an 8 gallon iron pot, with a cover of the same metal luted on with sand. About 20 to 25 pounds of coal are put into the pot, and distilled, which requires the combustion of about 25 pounds more of coals. The quantity of gas varies with the quality of the coals; it is passed through water into the reservoir, which only holds about 400 gallons, but in general more is produced; so that the overplus, perhaps 200 gallons, is wasted. From the reservoir the gas is conveyed around the house by means of old gun barrels, used as tubes, and coated once a year, or seldomer, with the produced tar.

"The gas flame is found superior to that of a lamp for soldering with the blow pipe. The moment the stop cock is turned on, the flame is ready for use, while with oil or cotton wick, the workmen are forced to wait until the lamp is sufficiently on fire."

The expense of this apparatus was £50, but he thought others could be put up for £40.

In regard to the light produced, Mr. Cook offers the following facts: "The lights employed in the manufactory are 18 or 20, equal to eighteen shillings a week for candles, for 20 weeks, which amounts to £18. It used to cost £30 a year for oil and cotton for the soldering lamps; and the coke is certainly worth £2 10s. a year, so that, setting the tar against any little accident that may happen, the whole produce may be taken at £50 10s. a year."

Supposing 50 lb. of coal are used daily, the weekly expenditure on that head will be 2 shillings, and allowing part of a man's time to attend to making the gas to be worth 5 shillings, the whole will be 7 shillings per week, or £18 4 shillings a year; this, however, is one-fourth more than it ought to be, because for 25 to 30 weeks the gas will not be required for lights. And adding to this expense £2 a year for interest on the cost of the apparatus, there will remain a saving of £30 6s. in the year.

For a family using only six candles and one lamp, a gas apparatus would cost from £10 to £12, the cost of which will be saved during the first year.

The critical remark of the editor of this paper is truly amusing, for, by a train of reasoning, he states that he is compelled to oppose the introduction of gas, because it will *raise the price of butcher's meat.* The editor argues that if gas supersedes candles, the price of tallow will fall; therefore, as the fat of animals will be reduced in value, butchers will have to charge a higher price for the leaner portion of the meat, so as to realize the value of the beasts. "*Therefore, as food is of more consequence than artificial light, it is rather to be depreciated.*"

A year later Mr. Cook read a second paper "On the Advantages of Coal Gas Light" (*Phil. Trans.* 98), which shows that the method of preparing the gas was very imperfect, and an unpleasant odor was given off when it was used. In regard to this, Mr. Cook says, in reference to this objection, that the smell occasioned by the gas is injurious to health, and that "it rather tends to preserve health by destroying contagion, *and purifying the air.*"

This absurd statement appeared to give satisfaction to the editor, who, in his observations on the paper, states: "Information of this kind has long been wanted, and those who have made the greatest bustle on the wonderful advantages attending the use of the gas light have, in this respect, been deficient." Possibly public opinion was leaning towards the introduction of gas, for the same editor, who in 1809 observed, on Mr. Murdock's paper, that "the expense of the apparatus will always be against its introduction on a small or middling scale," now observes, in 1810, "The statement of Mr. Cook clearly proves the great advantages connected with those lights, *even on a small scale.*"

It is not intended that the foregoing represents the history of the introduction of gas for illuminating purposes, but it gives phases of the question which are of interest at this moment, and shows that, as in the introduction of the electric light for the same purpose, its development was very gradual. It will be seen that the economy of both gas and electricity for lighting purposes was at first disputed, both were afterwards considered only adapted for large buildings, then came the time when each was shown to be fitted for domestic purposes. The introduction of gas was considered "*a bubble,*" and when all other objections had been exhausted, scientific testimony of that day finally stated that gas lighting would raise the price of beef. When gas lighting was first introduced, the idea of a great central manufactory for a city was not even dreamed of; possibly at that time the mere suggestion of such a design would have caused a panic; but that it was successfully accomplished we all know. Gas was also first used for lighting large buildings, but it required the genius of one man to invent a process for its purification, so as to make it practical for general illuminating purposes.

The reader, with a knowledge of recent events, can easily compare them with the facts here recorded respecting the early days of gas, and notice how history has again repeated itself.

First the possibility of using the electric light for general illuminating purposes was denied, then its adaptability for large buildings was admitted, and now finally its use for domestic purposes is unquestioned.

The economy of electric lighting was also assailed, but the arguments are now getting stale. As each consumer had at first to make his own gas, so the first idea of electric lighting was coupled with the necessity on the part of each consumer to own his own electric generator, and it was reserved for Edison to reform the whole system, and put it on a practical footing. He first publicly exhibited an electric lamp, that could compete with gas, and that was adapted for the general illumination of houses by electricity; he first subdivided the electric current, and thus demonstrated that its economic use was a possibility; and he will be the first to achieve the final triumph of establishing a central station for the manufacture of electricity and conducting it to the houses of the people.

Capitalists combining with scientific experts and patent pirates may endeavor to strip Edison of the honors due to him, earned by patient and exhaustive study of the question. That the electric light would eventually supersede gas for general illuminating purposes, no one doubted, but that Edison, by bringing to bear upon it his great inventive powers, combined with almost unlimited resources, has advanced the time for accomplishing the result by at least fifty years, will be admitted by all unprejudiced persons.—*J. M., in Science.*

VISUAL PURPLE.

By W. C. AYRES, M.D.

IN 1876 the late Professor Boll, of Rome, discovered that there existed in the retina of the frog a substance which was sensitive to light, and gave it the name of visual purple. Since that time his observations in regard to the frog have been extended to a variety of animals, and, among them, to man, and bidden fair to revolutionize all our knowledge of the physiology of nervous actions. It soon became known, however, that the seat of this photo-chemical substance was always in the rods and never in the cones; and, since the cones are the elements which occupy the region of distinct vision, the *fovea centralis*, and since the purple is never found in that locality, distinct vision, both for objects and for colors, must be independent of its existence. It is, nevertheless, always present in the retina under suitable circumstances, and, this being the case, it must have some definite physiological office to fill, and, of course, the question then becomes, What can be its nature and the purpose it serves?

In the first place, we know a great deal concerning its nature: for instance, if an animal be placed in the dark and its retina be afterward examined, each rod will be found to be full of the visual purple. (The retina must be prepared for inspection under the non-actinic sodium flame.) If such a retina be then brought into daylight the purple is rapidly bleached, but the phases it passes through in this bleaching are peculiarly significant. At first it becomes less purple, then chamois, and afterward yellow in color, but finally it is

reduced to white. W. Kühne, of Heidelberg, has studied these changes in their utmost detail, and has given the yellow the name of *visual yellow* and the white that of *visual white*. (See "Archives of the Physiological Institute in Heidelberg.")

I would remark incidentally that, in man and the higher animals, the purple is the only colored pigment in the retina, but that we find in birds, etc., a peculiar colored fat globule, first described by Hanover; and where these globules and the visual purple exist simultaneously their quantity is always in an inverse ratio, that is, the more chlorophane, xanthophane, and photophane, the less the quantity of visual purple. (See "Stable Colors of the Retina," by W. C. Ayres and W. Kühne, "Archives of the Physiological Laboratory in Heidelberg.")

In all the above-mentioned animals the visual purple is still sensitive to light, and consequently will go through the process of bleaching, but, when we pass down the scale, we soon come to a class where this compound is no longer sensitive to light, but must exert its influence as a stable pigment. ("Ueber die Stabschenfarbe der Cephalopodon," by C. Fr. W. Krukenberg, "Arch. d. Physiolog. Inst. in Heidelberg.")

One more step brings us to an eye in which the visual purple is not sensitive; but it is also entirely exterior to the retina, having its seat in the pigment epithelium. This I have found to be the case in a fish known as the blackfish, where it is seen in the shape of long purple crystals, which, when isolated, have a peculiar amœboid motion in themselves. However, in all those animals that perform their effective locomotion in heterogeneous light, the purple is sensitive, and, as we have before noticed, goes through a peculiar bleaching process; and it is to this that I wish to call special attention.

In Vol. I., Part 4, of the "Archives" already referred to, Kühne has given us the *absorption spectra* of the visual purple and the visual yellow. In the case of the purple, the absorption begins at the line C in the solar spectrum, or near the heat end, and attains its maximum midway between D and E. From E it decreases gradually to G, when the absorption curve falls rapidly through one degree of the solar scale, allowing all the indigo and purple light to pass through. In other words, the most actinic light is perfectly transmitted. The spectrum of the visual yellow is radically different from this, and its absorption is much more intense, although its color is not nearly so deep. In this spectrum all the rays up to F pass through unchanged, but at this point the curve mounts very rapidly, and the absorption is complete out to the ultra-violet light; *i. e.*, all the actinic waves are destroyed.

The generally-accepted opinion of the present day is that the action by which the terminations of the retinal elements receive their impressions is a photo-chemical one, and, if this be true, the above-described relation of the different absorptions of the visual purple and yellow cannot be overestimated. We shall find in it at least one direct office for this most important compound to fulfill.

One word more as to the nature of the purple. It is an albuminoid secretion from the black pigment epithelium of the retina. (See "Archiv. d. Physiolog. Inst. in Heidelberg." W. C. Ayres and W. Kühne.) When light has acted on the purple while the eye is in the orbit of a living animal, having its normal supply of blood, the bleaching of the purple to yellow is easy and comparatively rapid, whereas a further action, resulting in the reduction of the yellow to white, is difficult and slow. Also, as is natural to suppose, the restitution of the yellow to its primitive purple condition requires but little time or expenditure of energy on the part of the retina, but the change of white to yellow is very tardy.

Now, suppose that an eye has been in a bright light for some time and it is brought suddenly into a dark room—the common experience is, it does not see; but, after having remained for some time in a room not quite dark, we begin to distinguish objects which before were indiscernible. What must necessarily have been the condition of the retina during this change? When the eye was in the light a great portion of the purple had been reduced to yellow, and the yellow was absorbing almost the whole of what is known as the chemical portion of the solar spectrum, so that but little actinic light reached the cones; and the retina was working under the modified condition of great absorption of photo-chemical rays. When the eye was placed suddenly in the dark there must have been so much visual yellow that it absorbed nearly or quite all the light that passed into the eye, and, therefore, vision was impossible.

Now, the known condition is, that under such circumstances the yellow is rapidly transformed into purple, and the constitution of the purple lets all the chemical rays be transmitted. We then notice that we begin to see a little at first, and then more and more; and the time which we require to "get accustomed" to the dark is remarkably coincident with that which is required for the transformation of the visual yellow into visual purple. We have found, by actual examination of the retinæ of animals, that when the eye is accustomed to the dark it is rich in the purple pigment, and the yellow is entirely absent. Of course a reversed relation is gone through with when an eye is changed from the dark back into the light; it does not see, and the condition of the retina will fully explain the cause of its incapacity. Having been in the dark, the purple is in excess, and all the chemical rays are being transmitted; the eye, being brought suddenly into bright light, the same will go on, and the effect is that the eye will be overpowered and "dazzled." A rapid reduction of the purple to the yellow commences immediately, and just as the yellow is formed the excess of light will be absorbed, and the retina will begin to appreciate objects which it could not before. The time agrees in this transformation also.

If we wish to draw any conclusion from these facts, we are most certainly justified in saying that at least one office of the visual purple is to enable the eye to accustom itself to any circumstance, and by a continual self-adjustment to keep itself fitted to work to the true advantage under all conditions. The visual purple, when sensitive to light, would then be a conservative compound, so constituted as to allow *a more delicate photo-chemical substance in the cones* to produce excitations of the terminal retinal elements; or, if we hold the theory that the sensitive action of the retina in the perception of light results from the direct vibrations of the light waves, the action of the purple would, nevertheless, be the same, *i. e.*, to keep the cones continually in the proper condition to operate to the best advantage.

All eyes in which the purple is a stable pigment are imperfect, and so far they have been found only in fishes. The result would be the same whether the pigment were situated in the rods or in the epithelium, since, in both cases, each cone would be surrounded on all sides by a corona of pigment, and its absorption would accomplish the same protection. These eyes are never placed in a varying light, since they are all found in deep-sea fishes, that consequently are subjected to quite modified circumstances of life. The cornea of these fishes is of itself pigmented yellow, and the fact that the curvatures of the inner and outer corneal surfaces are not concentric would produce a high degree of astigmatism, and any such delicate arrangement as a sensitive purple would be superfluous, and consequently dispensed with by nature.—*N. Y. Medical Journal.*

METEOROLOGICAL USE OF THALLIUM PAPERS.

SCHOENE has given in a subsequent paper, the results of an extended series of experiments on the use of thallium paper for estimating approximately the oxidizing material in the atmosphere, whether it be hydrogen peroxide alone, or mixed with ozone, or perhaps also with other constituents hitherto unknown. The objection to Schönbein's ozonometer (potassium iodide on starch paper) and to Houzeau's ozonometer (potassium iodide on red litmus paper) lies in the fact that their materials are hygroscopic and their indications vary widely with the moisture of the air. Since dry ozone does not act on these papers, they must be moistened; and then the amount of moisture varies the result quite as much as the amount of ozone. Indeed, attention has been called to the larger amount of ozone near salt works and waterfalls, and the erroneous opinion advanced that ozone is formed when water is finely divided. And Böttger has stated that ozone is formed when ether is atomized; the fact being that the reaction he observed was due to the H_2O_2 always present in ether. Direct experiments with the Schönbein ozonometer and the psychrometer gave parallel curves; whence the author regards the former as only a crude hygrometer. These objections do not lie against the thallium paper, the oxidation to brown oxide by either ozone or hydrogen peroxide not requiring the presence of moisture, and the color therefore being independent of the hygrometric state of the air. Moreover, when well cared for the papers undergo no farther change of color and may be preserved indefinitely. The author prepares the thallium paper a few days before use, by dipping strips of Swedish filtering paper in a solution of thallous hydrate, and drying. The solution is prepared by pouring a solution of thallous sulphate into a boiling solution of barium hydrate, equivalent quantities being taken, the resulting solution of thallous hydrate being concentrated in vacuo until 100 c.c. contains 10 grammes Tl (OH). For use the strips are hung in the free air in a close vessel, preferably over caustic lime, for twelve hours. Other papers are used, made with a two per cent. solution. These are exposed for thirty-six hours. The coloration is determined by comparison with a scale having eleven degrees of intensity upon it. Compared with Schönbein's ozonometer, the results are in general directly opposite. The thallium papers show that the greatest effect is in the daytime, the iodide papers that it is at night. Yearly curves show that the former generally indicate a rise when the latter give a fall. The iodide curve follows closely that of relative humidity, clouds, and rain; the thallium curve stands in no relation to it. A table of results for the year 1879 is given in monthly means, of the two thallium papers, the ozonometer, the relative humidity, cloudiness, rain, and velocity of wind.—*G. F. B., in Ber. Berl. Chem. Ges.*

ANALYSIS OF FORAGE BISCUITS.

By C. J. H. WARDEN, Bengal Medical Staff, Chemical Examiner to Government.

THE forage biscuits which form the subject of the following report were forwarded to the Chemical Examiners' Department by the Assistant Commissary General, Calcutta.

The biscuits were circular in shape, with a central hole, and weighed on an average 100 grms. each. A physical examination resulted in the detection of linseed, peas, and husks, not unlike those of barley. The marked indications of phosphoric acid and iron, subsequently found in the ash, also favored the view of the presence of this cereal.

In order to obtain a sample for analysis portions of several biscuits were pulverized; 100 parts contained

	A.	B.	Mean.
Water.....	13·611	13·721	13·666
Albuminoids ..	15·514	15·673	15·594
Carbohydrates..	57·525	56·380	56·953
Fiber.....	1·022	1·453	1·237
Fat.....	7·326	7·920	7·623
Ash.....	5·002	4·853	4·927
	100·000	100·000	100·000

Albuminoids = N×6·33. Nitrogen was estimated by Varrentrap and Will's method, a long combustion tube being employed, and the ammonia absorbed by dilute hydrochloric acid, the chloride being weighed as the ammonic-platinic chloride. Fiber was determined by the acid and alkali process.

The ash was of a reddish color, and contained iron, phosphoric, sulphuric, and traces of nitric and carbonic acids, together with lime, etc. Chloride of sodium was present to the extent of 0·806 per cent. calculated on the biscuits, and was estimated in a portion which had been charred at a temperature below redness. The albuminoids, or nitrogenous constituents, are present to the extent of nearly 16 per cent. Grain *Cicer arietinum*, on which horses are largely fed in India, contains 22·7 per cent., peas 23 to 28 per cent., and barley and oats 12·9 and 14·3 per cent. respectively. The nitrogenous principles are, therefore, fairly represented.

Fat is present in rather larger amount than is usual in the diet of horses. Grain, barley, and oats contain 3·7, 2·7, and 5·5 per cent. respectively. It is possible that an excess of fat in the food might disagree after a time; but this is a point which can only be decided after actual experiment.

The linseed was probably in the form of meal, after removal of most of the oil, and was most likely added as a material with which to agglutinate the other ingredients, and so admit of a finer biscuit being manufactured. At the same time linseed is nutritious and assists in the formation of fat and muscle.

I have recently, through the courtesy of Messrs. Lord & Co., Calcutta, been furnished with a copy of the extract of the proceedings of a committee assembled at Meerut in June last, to report on these biscuits. Nine horses were selected for experiment, all country-breds, of nearly similar shape, size, and condition, and all subjected to the same treatment as regards work. They were watered three times a day before each feed; none of them had any bedding.

Lot 1. Consisting of three horses, were fed on 4 seers grain and about 15 seers grass daily.

Lot 2. Three horses were fed on 3 lb. biscuits and about 15 seers of grass.

Lot 3. Three horses were fed on 6 lb. of biscuits only, no grass being allowed.

The experiments commenced on the 25th March and terminated on the 18th June. The committee reported that the nourishing properties of the biscuits were very good, and that with one exception all the horses had kept their condition and carried good coats, so that they differed in no way from the other horses in the regiment.—*Chem. News.*

REFRIGERATING MIXTURES.

M. A. DITTE has communicated to the Paris Academy of Sciences some very interesting observations on the nature of the freezing mixtures produced by stirring up together some hydrated salt with an acid. The reduction of temperature observed when sulphate of soda is mixed with hydrochloric acid is shown to be not simply due to the solution of the salt in the acid. Double decomposition takes place in "accordance with the principle of maximum work." Chloride of sodium is produced, and this compound, being soluble in hydrochloric acid which is concentrated, is precipitated. The water which existed in the sulphate of soda in the solid form is thus set free, and becomes a liquid, absorbing a very large amount of heat. Now, if the hydrochloric acid is not concentrated acid, or not sufficiently concentrated, a portion of the chloride of sodium formed is dissolved; moreover, the decomposition is not complete, and so the maximum reduction of temperature is not obtained. When sixteen parts of sulphate of soda containing all its water of crystallization are mixed with twelve parts of the ordinary commercial hydrochloric acid the temperature of the mixture is reduced about 33° C. Similar effects are produced with mixtures of phosphate of soda, or sulphate of soda, with concentrated nitric acid, and the various alums (which contain a large amount of combined water) and phosphate of soda act likewise with hydrochloric acid. The cold produced in these freezing mixtures of acid and hydrated salt is, therefore, due to the large absorption of heat which occurs when solid (combined) water passes into the liquid (uncombined) state.

DETERMINATION OF GOLD AND SILVER IN ALLOYS AFTER QUARTATION WITH CADMIUM.

By FR. KRAUS.

TWO portions of the alloy, each of 0·25 gramme, are weighed off and placed with the cadmium in small porcelain vessels. A piece of potassium cyanide is melted in a porcelain capsule over the flame, and the metal thrown in. The melting together takes place readily, and is complete in a few minutes. By changing with two or three porcelain capsules, and having a vessel with warm water at hand, in which the melt is dissolved when sufficiently cool, twenty to thirty meltings can be executed in an hour. The two metallic granules are now thrown together into a small, long-necked flask, in which is nitric acid of specific gravity 1·30; a piece of wood charcoal is introduced to prevent bumping—which would rupture the globules—and heat is gently applied. The first solution lasts rather long, according to the proportion of gold; *e. g.*, an hour in case of fine gold. The solution is poured off, the boiling repeated with nitric acid of specific gravity 1·3 for ten minutes, the liquid again poured off, the globules rinsed with hot water, boiled for five minutes with water, which is poured off, and the flask filled with water is inverted into a porous earthen crucible, dried, ignited strongly, proceeding as in cupellation. In most cases the globules can be weighed separately. Silver is determined in the solution by titration with ammonium sulphocyanide according to Volhard's method.

DETERMINATION OF SILICON IN IRON AND STEEL.

By T. M. BROWN.

ONE gramme iron or steel is placed in a porcelain crucible with 25 c.c. nitric acid of 1·2 specific gravity. When the reaction is over 25 to 30 c.c. dilute sulphuric acid—1 part acid and 3 water—are added, and the solution is heated till the nitric acid is entirely or nearly expelled. When the residue is sufficiently cool water is cautiously added, and the contents of the capsule are heated till the crystals are perfectly dissolved. The solution is then filtered as hot as possible, and the residue washed first with hot water, then with 25 to 30 c.c. hydrochloric acid of specific gravity 1·20, and finally again with hot water. After drying and ignition the silica is obtained snow-white and granular.

MANUFACTURE OF PHOSPHORIC ACID.

By M. A. COLSON.

NATURAL phosphates, unground, are dissolved in dilute hydrochloric acid. When the acid has ceased to act the clear solution is run off from the insoluble matters and mixed with sulphuric acid enough to saturate all the dissolved lime, leaving a mixture of hydrochloric acid, dilute phosphoric acid, and calcium sulphate. This mixture is submitted to pressure to separate the sulphate from the free acids, which are then concentrated, and the hydrochloric acid is condensed and collected for use by means of ordinary columns.

COKE OF PETROLEUM.

By MM. L. PRUNIER and EUG. VARENNE.

IN the experiments of the authors, the accumulation of the carbon is effected with an increasing rapidity, and the weight of the molecule rises to a limit still little known, but which can be no other than the formation of insoluble bodies whose richness in carbon is equal or even inferior to that of the bodies which have remained soluble. We reach thus, by a progression easy to conceive, the term of the series which must equally include crystalline bodies such as graphite and diamond. It is known, on the other hand, that the higher polymers, when submitted to very high temperatures, seem to depolymerize themselves (as happens with metastyrolene), yielding gaseous carbon compounds.

IODINE FROM SEAWEEDS.

By DR. THIERCELIN.

THE most advantageous weeds for this purpose are the two varieties of *Fucus digitatus*. The author states that he has succeeded in extracting from the plant three per cent. of iodine.

FRANK BUCKLAND.

THE death of Mr. Frank Trevelyan Buckland, her Majesty's Inspector of Salmon Fisheries, was announced the last week of December, 1880. He was the eldest son of the Very Rev. William Buckland, D.D., Dean of Westminster, the eminent geologist. He was born December 17, 1826, and was educated at Winchester, and at Christ Church, Oxford. He inherited much of his father's originality and keen powers of observation, and from boyhood developed a strong bias toward natural history and physical science. He never pursued his father's favorite study of geology, but applied himself to the medical profession. Having studied medicine in Paris and London, and served as house surgeon to St. George's Hospital, he entered the Second Life Guards in 1854 as assistant surgeon. Mr. Buckland's passion for natural history, and especially the pisciculural branch of the science, soon absorbed all his thoughts. He left the Life Guards in 1863, and for some time was a constant contributor to the *Field* newspaper and other periodicals. In 1866, with the late Mr. W. Ffennell, the first Inspector of English Salmon Fisheries, Mr. Buckland projected and started *Land and Water*. He conducted its intelligence in regard to sea and river fisheries and practical natural history, and contributed to it up to the very day before his death. In 1867 Mr. Buckland was appointed Inspector of English Salmon Fisheries, and since then his labors have been unremitting. No one has done more to popularize the subject of fishery cultivation and preservation, not only in England, but throughout the world. His advice was sought by the Governments of Russia, Germany, France, and America, as well as our own colonies. His efforts for the introduction of salmon and trout into the Australian and New Zealand waters are well known. In 1870 Mr. Buckland was appointed special commissioner for the salmon fisheries of Scotland. He published a report on the Norfolk fisheries, which led to the Norfolk and Suffolk Fisheries Act of 1877. In the same year he was one of a Commission to inquire into the crab and lobster fisheries of England and Scotland, which resulted in an Act of Parliament for the protection of those mollusks. In 1877 he served on a commission of inquiry

FRANK BUCKLAND

into the herring fisheries. In the next year he was engaged upon the commission relative to the sea fisheries around England and Wales, the report upon which was published last year by Mr. Frank Buckland and Mr. Spencer Walpole. Mr. Buckland's researches into the mysterious salmon disease have attracted much attention It would be impossible to give a full list of his contributions toward the development and preservation of our fisheries. His museum at South Kensington, collected at his own expense, is a monument of the industry with which he sought to gather information connected with the fisheries for the public benefit.—*Illustrated London News.*

JOHANNES RUDOLF VON WAGNER.

WE have already briefly alluded to the loss suffered by chemistry in the sudden death from heart disease of Prof. Von Wagner, which occurred at Würzburg, October 4. Johannes Rudolf Wagner was born February 13, 1822, at Leipsic. As a student in the university of his native city he made choice of chemistry as a profession, and supplemented the then somewhat limited advantages of the Leipzic laboratory by a course of study at Paris, whither students from numerous countries were attracted by the brilliant lectures and investigations of Dumas. His residence there was followed by a lengthy journey to the various centers of scientific interest in France, Belgium, Holland, and Germany, after which he returned, in 1846, to Leipsic to accept a position as assistant in the chemical laboratory of the universary. In 1851 he was appointed Extraordinary Professor of Technical Chemistry at the Nürnberg Polytechnic. In 1856 he accepted a call to the chair of Technology at the University of Würzburg, a position which he occupied until the time of his death. During the same time he also filled two important offices, that of Director of the Technological Conservatory at Würzburg, and (until 1868) that of Royal Examiner of the establishments for Technical Instruction in Bavaria. His peculiar abilities and wide range of experience led to his being frequently sent abroad by the Bavarian government on scientific missions, notably in 1858 to England and Holland, and in 1861 to Paris. The same reasons led to his being called upon to play an important *rôle* in the International Exhibitions of the past twenty years. He was successively appointed on the juries for chemical products at the Exhibitions of London (1862), Paris (1867), and Amsterdam (1869). At Vienna (1873), he was the Chief Commissioner of Bavaria, and at Philadelphia (1876), he was a leading member of the German Commission. The marked services which he rendered in connection with the Vienna Exhibition were recognized by his sovereign, who raised him to the nobility, and decorated him with the Order of the Crown. Prof. Von Wagner was the recipient likewise of numerous decorations from most of the European countries.

The career of Wagner has been one of unusual and varied activity. Apart from the multifarious duties of an executive character which we have briefly enumerated, he found time to render to pure chemistry, and especially to applied chemistry, services of incalculable value. Like Poggendorff in physics and Kopp in pure chemistry, his inclination led him toward the literary side of his favorite studies, and it is on his accomplishments as an author that his fame chiefly rests. Still, as an investigator, Wagner possessed remarkable and many-sided aptitudes, and his name is associated with numerous researches, the majority of which aim at the practical application of scientific facts, or seek to ascertain the chemical nature of important industrial products. One of his first investigations (1847), was on yeast, and included a thorough study of its nature and growth, and especially of the influence exercised by the presence of foreign bodies on the phenomena of fermentation. In 1849 he commenced a research on the oil of rue, which was carried on at various intervals, and to which we owe much of our knowledge of the constituents of this important essence. In 1850 he assigned to the alkaloid conine the structure of a dibutyryl-amine, a formula verified long after by Schiff's synthesis (1871), of paraconine, and by Michael and Gundelach's brilliant synthesis a few months since, of methyl-conine. Among other noteworthy theoretical results, mention may be made of his extensive monograph on polymeric isomorphism (1851), and his experiments in the same year establishing the nature of mercur-ammonium compounds as substituted ammonias—mercury replacing hydrogen—by a distillation of the well-known "white precipitate" with amyl-mercaptan, which yielded sulphide of mercury and hydrochloride of amylamine. Shortly after he showed that the compounds imperatorin and peucedonine obtained from the roots of sulphur-wort and allied plants were identical, and established their chemical nature as angelate of the hydrate of peucedyle. One of Wagner's most important researches, commenced in 1850 and taken up several times since, had for an object the coloring-matters of fustic. In its course he discovered morin-tannic acid, which, in company with morin, gives to fustic wood its tinctorial properties. He studied carefully its reactions and its derivatives; and among the latter discovered pyrocatechin, the product of the destructive distillation of the acid. In 1853 he undertook a thorough examination of the oil of hops, separating the different chemical components, and finding among them quercitrin and morin-tannic acid. At this epoch he succeeded in obtaining the remarkable alloy formed by the union of four parts of potassium with 2¼ parts of sodium, which is liquid at ordinary temperatures, and resembles mercury in appearance. In 1867 he contributed an interesting research on the rapid increase of solubility of carbonates in water containing carbonic acid under various pressures. At the same time he broached a theory of the formation of deposits of a graphite, in which he attributed it to a decomposition of cyanides in nature analogous to that occurring in the manufacture of soda. Among his more important analytical researches were the determinations (1860), of the quantities of oil present in the nuts and seeds of many forest trees. As an able deviser of analytical methods Wagner exhibited numerous proofs. Among these mention may be made of the use of the iodine reaction for analyzing chlorides of lime (1859), the use of iodine likewise for the determination of the alkaloids (1861), the volumetric determination of tannic acid by means of sulphate of cinchonine (1866), the test for wool in silk fabrics by using nitro-prusside of sodium to show the presence of the sulphur contained in wool (1867), the application of ammonium vanadate to detect the presence of tannin in red wines (1877), and other tests for detecting methyl-cosine in the presence of eosine, nitrobenzene in the oil of bitter almonds, paraffine in bees-wax, stearic acid in paraffine, etc. Equally numerous were the improved methods of preparing chemical compounds and products introduced by him, including the preparation of pelargonate of ethyl, used extensively in perfumery, of finely-divided copper, of rufigallic acid, of calcium iodide, of precipitated alumina, of chloride of mercury, of arsenate of sodium, of benzoic acid, etc.

Among Wagner's purely technical researches, reference may be made to the application of pyrocatechin for photographic purposes (1855), the determination of densities for technical use (1859), the method for purifying water for tinctorial purposes (1863), the use of paraffine for preserving sodium, and his important research (1877), on the reactions of vanadium compounds with a large variety of organic commercial products, in the course of which he obtained several important tinctorial results.

As an author Prof. Von Wagner has manifested a degree of talent and a fertility surpassed by but few of his scientific contemporaries. An easy, lucid style, an intimate familiarity with the entire range of subjects touched upon, a fullness of detail united to a logical, systematic treatment of the matters in question, and a happy adaptation to the wants of even elementary knowledge, have rendered his works universal favorites. This is especially true of his "Handbook of Chemical Technology," which has survived a twelfth edition in Germany, and has been rendered accessible to French and English-speaking students by the masterly translations of Gautier and Crookes. It is doubtful whether in any other branch of applied science a manual exists which is so widely disseminated and has met with such practically universal success. Among Wagner's other works are: "Die Chemie" (1860; sixth edition 1873); "Theorie und Praxis der Gewerbe," 5 vols. (1857-64); "Die chemische Fabrikindustrie," second edition (1869); "Regesten der Sodafabrikation" (1866), and "Studien auf der Pariser Ausstellung" (1868). The technical journals of the past thirty years contain numerous monographs from his pen on individual branches of chemical manufacture, full of valuable information and statistics obtained by Wagner from private sources, and replete with those fruitful suggestions natural to a mind familiar at once with the facts of science and with their widespread applications. Unquestionably Wagner's chief literary achievement is his celebrated "Jahresbericht über die Leistungen der chemischen Technologie." Started eight years after the appearance of Liebig and Kopp's well-known "Jahresbericht" for chemistry in all its departments, this work of Wagner's has for a quarter of a century kept the industrial and scientific world promptly, thoroughly, and accurately informed of the progress made in every branch of applied chemistry. In its fullness and exactness it is an admirable type of the annual review, now regarded as indispensable for every branch of human activity by the German mind; and the vast influence which it has exercised upon the development of chemical industries is impossible to measure. The "Jahresbericht" for 1879, recently issued, forms a portly volume of 1,300 pages, with over one hundred wood cuts, and in its reviews evidences at every step a critical spirit able to cope with the scientific and practical questions constantly evoked.

Personally, Prof. Von Wagner was of a most attractive disposition, admired by his students not only for his rare talents as a lecturer, but also for his amiable character. His loss is felt as severely in a widespread social circle as in the world of science.—*T. H. N., in Nature.*

[AMERICAN JOURNAL OF SCIENCE.]

JAMES CRAIG WATSON.

JAMES CRAIG WATSON, Professor of Astronomy in the University of Wisconsin, and Director of the Washburne Observatory at Madison, Wis., died on the morning of Nov. 23, 1880, after an illness of one week, at the age of forty-two years and ten months. Professor Watson was one of the most gifted and distinguished of modern astronomers, and his life work is identified with the name of the University of Michigan.

He was born of American parentage, during a sojourn of his parents in Middlesex (now Elgin) County, Ontario, January 28, 1838. The mathematical genius revealed by the boy at the early age of nine, determined the father to secure him a liberal education; and the family accordingly removed to Ann Arbor, in 1850. Here James displayed equal aptitude for mathematical and linguistic studies, and being prepared for college, almost without the evidences of effort, he entered the University of Michigan in the autumn of 1853. He attained equal scholarly distinction as a student of ancient and modern languages, and of mathematics. It is said that before the close of his junior year, he had performed the phenomenal feat of reading from beginning to end the Mécanique Céleste of Laplace. During his senior year, he was the solitary pupil of Dr. Brünnow, and graduated in 1857. His mechanical tact was such that in the absence of a mathematical bent he would have become an eminent mechanician and inventor. While in college, some of his spare hours were spent in grinding lenses and the construction of a telescope. Other portions of his time he was compelled to devote to the earning of means to defray collegiate expenses.

During the two years succeeding his graduation, he was employed as assistant in the Observatory, and in the prosecution of studies for his second degree. In this work he displayed such remarkable aptitude as an observer, and such marvelous rapidity in his computations that, on the retirement of Dr. Brünnow, in June, 1859, young Watson succeeded him in the chair of Astronomy. He was already known as a frequent contributor to the *American Journal of Science*, Brünnow's "Astronomical Notices," Gould's *Astronomical Journal*, and the *Astronomische Nachrichten*, of Altona. Not less than twelve communications written before he was twenty-one are recorded in the Royal Society's "Catalogue of Scientific Papers," which also enumerates twenty-one others between 1859 and 1874. His wonderful keenness as an observer was signalized, while yet an undergraduate, by the discovery of a comet on the 29th day of April, 1856, and four months after graduation, by the discovery of a planet on the 20th of October, 1857, which, however, proved to have been observed by Luther a few days before, and has been named *Aglaia*. His observations of Donati's comet, in 1858, possess a standard value, and his computation of the orbit is recognized as authoritative. The interest awakened by this comet prompted to the preparation of "A Popular Treatise on Comets," published early in 1860.

In 1860, Dr. Brünnow resumed the directorship of the observatory, and young Watson was assigned to the chair of physics in the university, which he retained for three years, when, on the final retirement of Dr. Brünnow, Watson was

made Professor of Astronomy and Director of the Observatory—a position which he held and honored for sixteen years. Scarcely had he been clothed with full control of the instruments when he resumed his remarkable career of discovery. There seemed almost a magic in his powers. Unrecognized celestial objects seemed to crowd spontaneously upon his notice. On September 14, 1863, he made his first independent planetary discovery. This was *Eurynome*. On January 9, 1864, he discovered the comet since known as 1863 VI., which Respighi, as it proved, had already noted. On the 9th of October, 1865, he discovered a planet which also proved to have been announced by Peters, and has since been named *Io*. He discovered *Minerva*, August 24, and *Aurora*, September 6, 1867. During 1868, he added no less than six minor planets to the solar system, furnishing the only instance in which the list of planetary discoverers presents the same name four times in immediate succession.

Meanwhile he was engaged upon a work which might well have engrossed all his powers, and must have quite exceeded the abilities of any but a gifted mathematical genius. It was no less than a complete digest of the results and methods of all the great writers on theoretical astronomy, and an independent development of the great principles of the science. "Having carefully read the works of the great masters," he says in his preface, "my plan was to prepare a complete work on the subject, commencing with the fundamental principles of dynamics, and systematically treating, from one point of view, all the problems presented." This broad plan, conceived by a young man of twenty-eight, and completed when twenty-nine, was executed with ability so commanding, that the work, on its appearance, in 1869, was immediately accepted as an authoritative exposition of the higher principles and processes of dynamical astronomy, and was made a text book at Leipsic, at Paris, and at Greenwich. The same year he was sent by the General Government on an expedition to observe the solar eclipse at Mt. Pleasant, Iowa; and in 1870, to Carlentini, Sicily, for a similar purpose. In 1874 he was appointed to the charge of an expedition to Peking, China, to observe the transit of Venus. His observations were favored by the weather and conducted with consummate skill. The results, though reduced and discussed, are not yet published. Even at the antipodes, fresh discoveries awaited him. He had already raised his list of planetary discoveries to seventeen, and now added *Juewa*, the eighteenth. In 1876, he was one of the judges of awards at the Centennial Exhibition, and wrote the celebrated "Report on Horological Instruments." In 1878 also appeared his Tables for the Calculation of Simple and Compound Interest—a work which, in spite of the subject, is marked by great originality, and demanded a vast amount of wearisome labor. The same year he was sent by the General Government in charge of an expedition to Wyoming, to observe the total solar eclipse. Professor Watson, having long entertained a belief in the existence of an intra Mercurial planet, as well as of an extra Neptunian one, gave special attention, at this time, to a search for the former, and was the first astronomer to note certainly (July 29, 1878) the existence and position of the planet Vulcan. He also satisfied himself of the existence of a second intra Mercurial planet. This brought the number of his original planetary discoveries to twenty-six (including one lost July 29, 1873, and two anticipated). He was now animated by an intense desire to control instruments of suitable power and adjustment to confirm his last observations, and enable him to detect the outlying planet beyond Neptune. Coincidently came the invitation to assume the charge of the Washburne Observatory at Madison, Wis., which was to be improved and newly equipped with instruments far more efficient than those at Ann Arbor. The temptation was great, but he naturally clung to his Alma Mater, whose authorities made such efforts as they thought authorized to content their astronomer. But the requisite means could only be obtained by a grant from the legislature—a measure defeated by an inadequate appreciation of the honor shed upon the State by such a name as Watson's. Reluctantly, but sustained by a high and noble aspiration, he removed, in the summer of 1879, to Madison, and immediately devoted himself with intense energy to remodeling the observatory structure, and introducing some original provisions thought to be suited to the special researches on which he was bent. A cellar twenty feet deep was sunk at the bottom of the first slope of observatory hill. Into this light was to be thrown through a long tube, from powerful reflectors on the top of the hill. This, with other accessory work, was actually in progress, when a severe cold brought on peritonitis, which over confidence in his physical powers permitted to reach a fatal stage before medical aid was summoned. His remains, accompanied by an escort from the University of Wisconsin, were removed to Ann Arbor, where they lay in state, in the university, during the 25th of November, and on the following day, with due honors and imposing ceremonies conducted by his late colleagues, were reverently laid beneath the shade of Oakland Cemetery.

Professor Watson possessed extraordinary intellectual endowments. His quickness of perception nothing escaped. His mathematical intuitions scorned the ordinary processes of calculation, and gave him a masterly command of mathematical logic and formulæ, which made so many portions of his work on Theoretical Astronomy strictly original, and all parts virtually his own. Yet he never mentions any claim to originality, but pursues his majestic intellectual march with the dignity almost of an inspiration. His memory served him equally well. It was both circumstantial and philosophical. Every new observation was immediately illuminated by all which he had previously observed or known, and he saw instantly the proper conclusions. His mechanical gifts gave him perfect command of instruments and their construction, and the Washburne Observatory would have been equipped with several of his inventions. His versatility extended to matters of business. He was for years the Actuary of the Michigan Mutual Life Insurance Company, and performed service pronounced invaluable. He managed his private means with such success that he died possessed of a considerable fortune which his will secures to the National Academy of Science. Physically, he was vigorous and healthy, and reached, in the last years of his life, a weight of two hundred and forty pounds. His religious nature held fast to the fundamental religious beliefs. He used to say it is impossible for a mathematician to be an atheist; and his works offer frequent recognition of the being of the supreme Creator and Governor of the Universe.

The world was not slow to recognize his worth. He was elected a member of the National Academy of Science, in 1867, and of the Royal Academy of Sciences in Italy, in 1870. He received the degree of Doctor of Philosophy from the University of Leipsic, in 1870; and the French Academy of Sciences conferred upon him the Lalande gold medal for the discovery of six new planets in one year. Yale College honored him with the degree of Doctor of Philosophy, in 1871. In 1875, the Khedive made him Knight Commander of the Imperial Order of Medjidich of Turkey and Egypt. He was elected member of the American Philosophical Society in 1877, and received, the same year, the degree of Doctor of Laws from Columbia College.

A. WINCHELL.

[From SCIENCE.]

TYCHO BRAHE'S NEW STAR.

ON November 11, 1572, Tycho Brahe noticed a new and very bright star in the constellation Cassiopeia. Afterwards it appeared that this star had been seen before at various places in Europe, and Tycho, in order to fix its position, and to determine whether it moved, began a series of measures with his sextant, by which he connected the position of the new star with nine known stars in the same constellation. The new star shone with wonderful brightness, being brighter than the planet Jupiter, and, according to some reports, it was visible in full daylight. In January, 1573, its brightness began to wane, and in May, of the same year, it was only of the second magnitude, or as bright as Polaris. It remained visible to the naked eye, however, until March, 1574.

This star was also remarkable for the changes of color that it exhibited. At first it was white, then it became yellow, and finally, red. But in May, 1573, it was again of a dull white color, and remained so until it disappeared.

Although many cases have occurred of new stars blazing out for a short time, and then fading away beyond the sight of the naked eye, such as those of 1866 and 1876, yet Tycho's star, on account of its brilliancy and its long duration, is the most remarkable of any star of this kind of which we have any authentic record; and his observations of it have been carefully reduced and discussed by several astronomers. Professor D'Arrest, of Copenhagen, made a very complete catalogue and chart of 212 stars, which are within a distance of ten minutes from the position of Tycho's star. This catalogue is for the year 1865, and it will serve for a standard of reference in case Tycho's star should again blaze out. Mr. J. R. Hind, of England, by the reduction of a part of Tycho's observations, found the position of the new star to be for 1865,

A. R. = 4° 16′ 48″: Decl. = + 63° 23′ 5″.

(Monthly Notices, Royal Astronomical Society, vol. 21, p. 233.) From a more complete reduction of Tycho's observations Argelander found for 1865,

A. R. = 4° 19′ 58″ : Decl. = + 63° 23′ 55″.

(Astronomische Nachrichten, Band 62, p. 274.) This position agrees very well with that of a small star of the 10½th magnitude, which is No. 123 of D'Arrest's catalogue. The position of this small star for 1865 is,

A. R. = 4° 19′ 30″: Decl. = + 63° 22′ 54″.

When we remember that Tycho's observations were made without the aid of telescopes or of any magnifying power, we may consider the difference of these positions as within the limits of the probable error of his determination. We conclude, therefore, that Tycho's star is still visible in our telescopes, and that its brilliant appearance in 1572 was only an extreme case of the variations of light that are frequently happening among the stars.

John Goodricke, an English astronomer, who, in 1782, determined the period of the variability of the famous star Algol, thought that Tycho's star might be the same as the new stars reported to have been seen in the years 945 and 1264. This would make the period of its variability between 300 and 320 years, and hence this star should reappear in the latter part of the present century. Goodricke's conjecture seems to be very uncertain, since the reports for the years 945 and 1264 are extremely vague. It will be seen that if we assume the period of the variability of Tycho's star to be 315 years, five such periods would carry it back to near the beginning of the Christian era. Astrologers and others have not been slow to catch at such analogies, and to base predictions on these uncertain data; and thus we have it asserted that Tycho's star is identical with the Star of Bethlehem, and that it will reappear in the year 1887, with wars and social revolutions. Of course it is impossible to reply to such assertions. Wars and social revolutions are continually going on, and such grim predictions are as safe, therefore, as it is to say that to-morrow the winds will be variable, or that we shall have "rain in areas;" or snow next January. The only wonder is that intelligent people are imposed on by such assertions.

At the present time more than a hundred variable stars are known to astronomers, and every year increases their number. Many of their periods are well determined, but what causes the variations of light we do not know. The so-called new stars may be only extreme cases of the variable stars, and the appearance of one is an interesting astronomical phenomenon which should be carefully observed. There is a rich field for observation and for study.

A. HALL.

Washington, D. C., Nov. 29, 1880.

GLACIAL OBSERVATIONS IN THE WIND RIVER MOUNTAINS.

By CHARLES F. BLACKBURN.

MUCH has been written of late years by various physicists about the geology and natural history of this noble range. The object of this letter is to give some information regarding the very interesting glacial region which occurs along the summit of these mountains.

During the months of August and September, 1880, the writer, accompanied by Messrs. Johnson and Menefee, were engaged in investigating the glacial, geological, and physical phenomena of the range; with, however, the objective purpose of determining the metallic wealth of the region. So, as my work lacked much of gathering full data of the glaciers, and, moreover, as this communication will give only a resume taken from my itinerary, I am fully aware of the fact that the description may lack much in giving important details, which are inevitably omitted.

For the topographical features of the region I take the liberty to refer the readers to the excellent maps of Dr. F. V. Hayden. Along the summit of the Wind River range, between Wind River peak and the head of Tory creek, occurs a very interesting and

EXTENSIVE GLACIAL FIELD.

This important region has the venerable Fremont's peak for its keystone center. Living glaciers exist in the immediate vicinity, while others of considerable magnitude occur for a distance of thirty miles each way from Fremont along the trend of the range.

The writer ascended four of the higher summit peaks; also others that seem to vie with those that divide the continental waters, around all of which glaciers (some living) were observed. The great center, however, is in the immediate vicinity of Fremont's peak, the trend of range being north 45° west. Altitude of the summit peaks varying, according to Dr. Hayden, from 13,400 to 13,790 feet; the former being the elevation of Wind River and the latter that of Fremont's peak. My own observations give higher elevations to all of these points—*e. g.*, I found Fremont's peak to be 14,500 feet. However, as my estimates were taken with aneroid alone, I concede my results as merely approximations, and will not question the decision, but rather accept the determinations of Dr. Hayden as competent authority, unless proved erroneous by future investigators.

The latitude of this glacial region includes about 1° lying between 42° 45′ and 43° 45′ north; longitude, between 109° and 110° west. Along the northeast base of Fremont's peak occurs the great

ICE SHEET,

extending for fully twenty miles, and lacking only a few rods at places of being contiguous throughout. At the heads of all the cañons the depressions may be observed heaped up with these dynamical frozen giants. From the foot of the glaciers to the base of the range occur profound gorges, over the surface of which exist *roches moutonees*, lateral and terminal, moraines, and many beautiful perpetual frozen lakes, over which the writer walked in August. Some of these

REMARKABLE LAKES,

were really frozen solid; no water being visible. The depth of the glaciers about the northeast base of Fremont's peak are evidently from 50 to 500 feet; width, varying from one-half to two miles; length, from one to four miles. Many were observed to be moving, but, as usual, at a very slow rate. Another very interesting phenomena, regarding the glaciers of this region, is the profound attrition and erosion wrought by those that have long since vanished. Those yet lingering on these Alpine heights are mere pygmies, merely remnants of former greatness. It is very easy for the geologist to read their awe-inspiring records, while meandering over these frozen and solitary heights. Their history is legible in bold relief. The bottoms of these glacial cañons are composed principally of groups of *roches moutonees*, granite and gneiss hummocks, retaining their myriads of grooves and scorings; while often these crystalline tops present a beautiful polish, all done by the moving, but now vanished, mountains of ice.

Agassiz's fondlings (glaciated bowlders) were observed all around the range, often several miles from its base. Large terminal moraines occur along the base, between Buffalo lake and Tory creek, especially in the vicinity of Dinwidee creek. Also about the head of the latter stream the largest living glaciers may be observed that exist in the Wild River Mountains. While investigating the

OROGRAPHICAL PHENOMENA

of this great range, the mind is almost bewildered in grasping, or comprehending, the magnitude of causes and effects that lie before his vision. Chemical and mechanical denudation has wrought such profound topographical changes in the contour of the range that its present orographical relief seems almost incredible; Alpine heights and isolated pinnacles—awe-inspiring—wearing their blue glacial gems in majestic silence; huge blocks of granite and gneiss, hills in themselves, occur on all sides, while deep chasms exist, filled with snow and ice which never melt.

Great amphitheaters, or horseshoe-like cañons, occur about Fremont's peak—vertical walls standing more than 2,000 feet high—while, looming still above these, occur rugged crags, or granite domes, from which magnificent views of the surrounding country may be had. From these dizzy heights the observer may look over thousands of square miles, many of which show true rugged grandeur. So intense is the sublimity that pervades the noble sights from these lofty points that the observer becomes lost at his own insignificance, and hardly ventures a conception of his greatness to be more than "simply a terrestrial parasite." Lowering the eyes he meets the great organic records; the fossiliferous tomb, or nature's profound book of evolution. Beginning with the primordial and glancing through the series to the quaternary, the observer is again lost in trying to grasp, or comprehend, the great antiquity of this great natural book (the only true history of creation), and for a consolation he can truly congratulate himself on being so fortunate as to be classed with the humble *genus homo*, and allowed the blessed privilege to live in the glorious circle of scientific light.

As I have previously said my description regarding the glaciers would not give any details, it gives me much pleasure to announce to scientific men that such a region does exist in our country, and those who wish to become acquainted with glacial phenomena need not go to the far away Alps to acquire his information.—*Mining and Scientific Press.*

GOLD IN NEWFOUNDLAND.

THE discoveries of gold made in Newfoundland during the past season have aroused considerable interest in the colony. The following report on the auriferous district by the official geologist, Sir Alexander Murray, indicates a possibility of the island becoming as celebrated for its mines as it has been for its fisheries. Sir Alexander says, under date of October 25:

Reports having been circulated for some time past that gold had been discovered in quartz veins in the regions near Brigus, of Conception Bay, I considered it my duty to make a personal examination of the ground and to have portions of the veins tested by blasting under my own immediate supervision. These rumors of the presence of the precious metal have naturally had the effect of inducing people to make applications at the Surveyor-General's Office for licenses of search over the supposed auriferous area. I proceeded to Brigus on Monday, September 27, and on the afternoon of the same day visited the locality where, according to report, gold had been found. Here I selected and marked out a series of spots upon the quartz for trial, and on the following day, which proved a rainy one and unfit for experimenting, I inspected another area about two miles southwest from the former place and nearly in the strike of the quartz-bearing strata, where I found the rocks, with their reticulations of quartz veins, to be nearly identical in all respects. This latter place is known locally as Fox Hill, and from it sundry specimens of gold are said to have been taken, one of which is in my possession. The place where I finally determined to try the first blast is situated near the

so-called Brigus Lookout, about equidistant from two peaks, each a triangulation point of the Admiralty surveyors, the heights above the sea being marked on the chart respectively 408 and 418 feet.

A SUCCESSFUL BLAST.

By the first blast from two to three cubic feet of rock was removed, all of which was carefully broken up, washed, and examined, which operation finally resulted in the display of ten or twelve distinct "sights" of gold. In one fragment, largely charged with dark green chlorite, the gold shows itself in three places distinctly, while many small specks are perceptible by means of a good lens. The fracture of a fragment of milky-white and translucent quartz, which was broken off the large piece, revealed two large patches of gold, both of which, together, if removed from the matrix, would probably produce about a pennyweight of the metal; while several small masses or nuggets were found adhering to the small broken fragments of quartz at the bottom of the pail in which the rock was washed, the largest of which contained about ten or twelve grains of gold. From some specimens, in which no gold was perceptible to the naked eye, which I had selected for analysis, I found among the dust at the bottom of the bag in which it was carried a small nugget weighing three grains. A second shot was tried on the same lead, a few yards distant from the first, but, owing to our imperfect implements, it failed to blow out more than a few pounds of rock, in which no gold was perceptible. In the specimen I procured from Fox Hill the metal occurs thickly in the minutest specks, scarcely, if at all, perceptible to the naked eye, but readily recognized under the lens, where it chiefly surrounds a small patch of chlorite.

The rock formation, intersected by these auriferous quartz veins, is of Huronian or intermediate age, or of the group of strata next below the Aspidella slates of St. Johns. The group consists chiefly of greenish, fine-grained felsite slates, which, judging by the weathering of the exposed surfaces, are also magnesian and ferruginous. The cleavage is exactly coincident with the bedding, and the slates occasionally split into very fine laminæ, but frequently into strong, stout slabs, which are used to a considerable extent at Brigus for paving, for hearth stones, and for building foundations and walls. A dip taken on the beds just in front of the place where the gold was found was north 56° west by compass, or north 88° west from the true meridian, or of inclination 45°. Parallel joints intersect the strata bearing south 80° west magnetic, or north 68° west true. By the side of the road at Brigus the dip on some strong slabby beds was found to be north 42° west magnetic, or north 74° west true, or of inclination 40°.

DESCRIPTION OF THE COUNTRY.

A rough and hummocky belt of country, from three-quarters to one mile wide, which forms the nucleus of the peninsula between Bay de Grase and Brigus Harbor, is thickly intersected by reticulating quartz veins, varying in thickness from less than an inch to upward of a foot, which often appear to ramify from a central base or great mass of quartz, often extending over many square yards, and usually forming low, isolated hummocks or hills. The general run of the belt is as nearly as possible northeast and southwest from the true meridian, having been traced in a southwest direction from Brigus Lookout as far as Fox Hill, and, as I am informed, can be traced several miles more in the same direction. Thus, although many of the veins, both small and large, may be seen for considerable distances to run exactly parallel with the bedding, the network of the whole mass runs obliquely to the strike of the beds, which are also minutely intersected by the smaller veins crossing and reticulating in all directions. I nowhere observed anything to indicate a true fissure vein, and consider these with gold as altogether veins of segregation.

The resemblance in general character of the strata with their included auriferous quartz veins in Newfoundland, to those of Nova Scotia, must strike any one who has visited the two countries with the purpose of studying their geological features, and I venture to say that the description given of the latter country by Dr. J. W. Dawson might in many respects equally apply to the former, although, according to that author, the auriferous country of Nova Scotia is supposed to be of Lower Silurian age, while that of Newfoundland is undoubtedly unconformably below the Primordial Group, which, with abundant characteristic fossils, skirts the shores of Conception Bay. Without presuming to offer an opinion as regards the age of the Nova Scotian strata, the fact of the resemblance is suggestive.

Chlorite is profusely disseminated through the quartz veins, filling up cracks and drusy cavities, and it was observed that the visible gold was always in or near a patch of chlorite. Some specimens which were procured at the place of trial presented small cubes of galena, minute cubical iron pyrites, and, in a few instances, small crystals of sulphate of copper, together with specks or grains of gold.

ENCOURAGEMENT TO PROSPECTORS.

That a large area of country in the regions referred to is auriferous there can scarcely be a doubt, although nothing short of actual mining and practical experience can possibly prove what the value of the product may be, or whether the prospects of obtaining a remunerative return for the necessary outlay are favorable or otherwise. The specimens which have been obtained, although an unquestionable evidence of the presence of the precious metal, cannot by any means be taken as indicative of a certain average yield; indeed, to quote the words of Dr. Dawson, from his "Acadian Geology," page 626, "It is not easy from mere inspection of the veinstone to predicate as to its value, since the gold is usually invisible to the eye." And again, at the following page, when treating of the characteristics of the Waverley Mine, he says: "Visible gold is rare in this vein at present, the greater part being in a minutely disseminated and invisible state." An analysis of quartz collected in which gold is imperceptible to the naked eye may aid in revealing some evidence of its constancy, and may throw some light upon the possible average of superficial contents over certain areas surrounded by similar circumstances; but it may be safely predicted that the irregularities of distribution so conspicuously displayed by the veins on the surface will extend beneath it, and that it will be mainly on the stronger and more persistent bands, where intercalated with the strata, that mining will extend to any considerable depth.

The indications of gold in this country, then, are sufficiently favorable to merit a fair trial, and there are good reasons to hope and expect that ample capital applied to skilled and judicious labor may be found remunerative to future adventurers, while a new industry will be added to give employment to the laboring population of the island, and possibly bring this despised and but little known country into more prominence and consideration abroad than it hitherto has enjoyed.

[AMERICAN NATURALIST.]

AN ADDRESS TO THE FOSSIL BONES IN A PRIVATE MUSEUM.

By JAMES S. LIPPINCOTT.

"AND you have walked about—how strange a story!"
In days gone by, a million years or so,
When giant saurians were in all their glory
In the dim twilight of the long ago!
When Hadrosaurus reared his height stupendous,
And Aquilunguine Lælaps leaped tremendous!

Could ye but speak, what stories you could tell us!
How on the oozy flats you floundered free;
Elasmosaur and all his scaly fellows
That fished and paddled the Cretaceous sea,
And Mossasaurus, how he showed his tushes
Ages ere Moses boated 'mong the rushes!

That "there were giants in those days" is certain,
Not such as those by Scripture story told,
Nor known to us till science raised the curtain,
Their length and breadth and stature to unfold;
Monsters of flesh and bone and horny mail,
And jaws and claws and ponderous length of tail.

Oft have we queried, Wherefore had ye birth,
And wherefore sent into a world like this
Ages ere perfect man appeared on earth?
As told in chapter first of Genesis,
Of which our Savants have not yet been able
To show how much is fact, how much is fable!

The "dark idolater of chance" may learn
A lesson pregnant from your gray remains,
See proof of plans, deep-laid, he may not spurn,
By Power Creative, through all time the same;
See glimpses of the slow evolving plan
Developing the monad up to man.

Then hail your advent to the light of day!
A revelation of old time to this,
Along the darkened past a brilliant ray
Lighting an else unfathomable abyss!
And hail to him whose skill your import can make plain,
Can reconstruct the past and make it live again!

REPLY TO J. S. L.

My dearest cousin, several times removed,
Since you have called me from the vasty deep
To witness how our race has been improved,
Pray hear my answer ere you go to sleep.

And first I hold that it is not polite
To call relations by such horrid names
As Hadro-mosa-sauri, which excite
Suspicion of the justness of your claims.

You seem, in fact, to have ransacked your brains
To find some endless word to suit my bones;
I'll take some little pity on your pains,
And tell you plainly that "my name is Jones!"

And I was born so very long before
Your puny race appeared upon the earth,
That human fancy ne'er may hope to soar
Back to the bygone age which saw my birth.

That to each other we have not been known
Is owing to your most egregious fault;
For this confounded piece of marly stone
Has served for ages for my burial vault.

Your ancient Scripture cannot be so old
Or nigh as perfect as this mass of rocks,
In which the patient seeker may behold
Foundations of a faith most orthodox.

It is not treating me as I deserve
To end the monad series with a man;
Presumption, founded on some extra nerve
Which you possess, does not destroy the plan.

Be warned in time lest overbearing pride
May be the chief occasion of your fall,
Let future beings 'twixt us both decide
Which was the master and which was the thrall.

Farewell! my voice is now for ever hushed,
No more to be evoked by prose or rhyme;
The hue of health which once my temples flushed
Has changed to that of carbonate of lime!
Farewell! at least until the end of time.

"GRAIN" IN PHOTO-ENGRAVING.

MAJOR WATERHOUSE'S last method is exceedingly ingenious; for, although the grain obtained is in reality a mechanical one, yet it is discriminating, being finer in the lights and coarser in the shadows. Briefly described, it consists of developing an ordinary carbon print on a silvered copper-plate, as in his former process, and after immersing it in a solution of bichromate of potash (the action of which does not appear quite clear) some fine "graining sand," which has been previously treated with beeswax to prevent permanent adhesion, is sifted, and the whole allowed to dry. When dry the sand is removed and the image is found perfectly grained, the grain being coarser in the shadows than in the lights. The plate is then treated with plumbago to give the gelatine surface conductibility, and from it is then produced the electrotype plate for printing from.

The theory of the process appears to be this: A carbon print when first developed is exceedingly soft and tender upon the surface, being, in fact, little more than a semi-soluble jelly, to which almost anything will adhere. The sand on coming in contact with this surface sinks in, and, as the gelatine dries and contracts, it draws the particles of sand deeper and deeper into the film in proportion to the thickness of the latter. In the half tints, where the coating of gelatine is thinner, the particles do not sink so deeply, and in the high lights, where there is scarcely any gelatine at all, only the extreme points of the sand get imprisoned, thus producing only a very fine grain indeed. It will thus be seen that the varying size of the grain is due to the depth to which the particles of sand penetrate into the film.

That the process is a practical one is proved by the examples shown at the meeting, which, though but crude experiments—and quite untouched—were such that any skilful engraver with scraper and burin could quickly transform into excellent printing plates. One of the examples shown was about the most crucial test that the process could be put to, namely, a portrait from life, the result being eminently satisfactory.—*Brit. Jour. of Photography.*

SOUND OF CANNON.

To the Editor of the Scientific American:

The communication in the SCIENTIFIC AMERICAN of the 15th inst., inquiring how far the sound of cannon will travel, brings to my mind an incident which occurred at Lawrence (Far Rockaway), Long Island, a few years ago. I was sitting in company with several gentlemen upon the front piazza of a country house one warm evening in summer, when another of the party and myself suddenly observed a faint flash, as of distant lightning. Shortly afterward the report of the nine o'clock gun at Fort Hamilton reached us, and from the length of the interval between the two occurrences we had no doubt that the flash we had seen was that of the nine o'clock gun at the moment of discharge. Lawrence is distant from Fort Hamilton probably not less than fifteen miles in an air-line, and was it not remarkable that we could have seen the flash? M.

Breckinridge, Colo., January, 1881.

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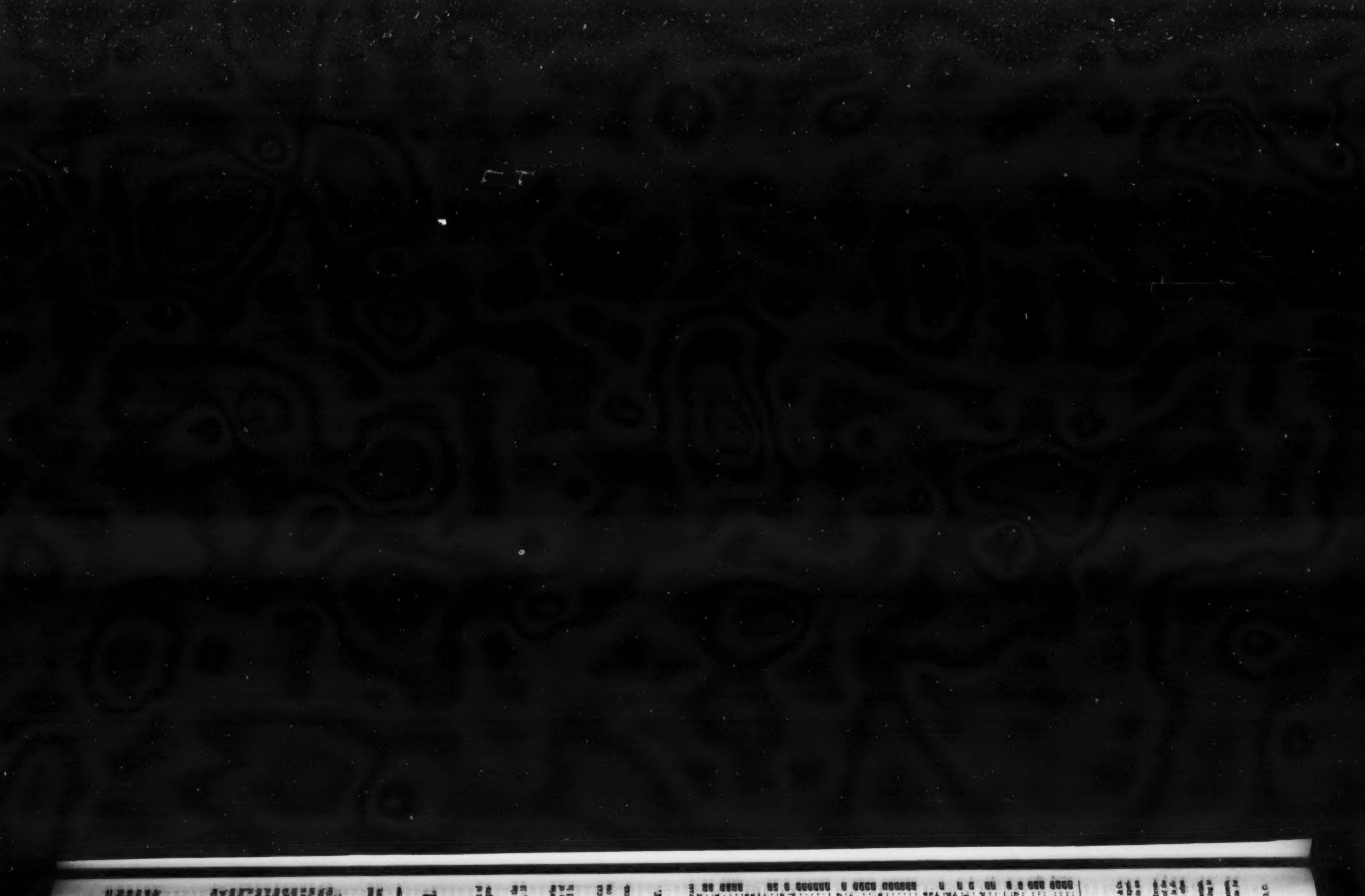
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